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THE LEARNING PROCESS IN YOUNG CHILDREN

An Experimental Study in Association

by

JULIA A. KIRKWOOD, PH.D.

PUBLISHED BY THE UNIVERSITY, IOWA CITY

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FOREWORD

The psychology of the learning process has been a fertile and interesting field for much experimentation in the learning of school children, in the analysis of the mental traits of adults, and in the behavior of animals, but a very limited amount of detailed work has been undertaken in this field with preschool children. This study of learning by association reaction by Dr. Kirkwood is one of the series of special studies undertaken in the Iowa Child Welfare Research Station as a part of a comprehensive program for the investigation of the nature and development of intelligence in young children. It is a portion of a thesis submitted in partial fulfillment of the requirements for the doctorate in child psychology.

The author presents the results of experiments with 180 children between the ages of two and six years, grouped for study of various phases of the problem of learning and relearning. These include interesting data on the learning of the material according to various forms of presentation, on learning on successive and on alternate days, relearning after an interval of one year, an analysis of the associations as shown by the correct and incorrect responses of the children, types of individual learning curves, and the correlations between general intelligence and learning. The results will form the basis for a more general and comprehensive investigation into the learning situations involved in the daily activities of young children.

BIRD T. BALDWIN

Office of the Director
Iowa Child Welfare Research Station
State University of Iowa
May 1, 1926

CONTENTS

CHAPTER I

MATERIAL, FORMS OF PRESENTATION, AND METHODS OF LEARNING IN AN ASSOCIATION REACTION LEARNING EXPERIMENT

In looking over the field of experimental work on the learning process, one finds that the subjects used have been animals, preschool children, school children, and adults. When thinking of learning, one is likely to think of it in connection with children, yet the literature shows that at least sixteen different learning tests have been used with adult subjects, four with school children, and two only with preschool children. Animals have been given, as a rule, either a maze or a puzzle box test in the study of their progress in learning. The first test of learning to be used with preschool children was the card sorting test;[160] later a specially devised test was used by one investigator to study the young child's ability to learn to recognize words.[162] School children have been given learning tests based upon code translating, maze learning, addition, and substitution. The learning process of adults has been studied by means of the following tests: ball tossing, code translating, substitution, maze learning, typewriting, telegraphy, addition, multiplication, nonsense syllables, sensible material, marble distribution, card sorting, cube formation, mirror tracing, javelin throwing, and hand movements.[1]

As there have been so few investigations into the problem of how children learn, particularly how young children learn, this phase of the study of the learning process is one in which there is need for more experimentation in regard to many of the different factors involved in an analysis of how learning takes place and of the factors that influence the rate of learning. If children are to be taught efficiently, there must be thorough scientific knowledge of the process by which a child learns. This knowledge can be derived only from experimental results obtained by placing the

1. This study is Part II of a thesis on file in the library of the State University of Iowa. Part I is a general review of the literature on the learning process, with references. The references are included in this abridged form of the thesis in order to indicate the scope of the material included in Part I.

child in a controlled learning situation and by analyzing quantitatively and qualitatively the results obtained. It was in the hope of throwing light on some of the problems involved in the learning process of young children that this investigation was undertaken. Some of these problems, such as effect of distribution of practice and rest periods, the problem of interference and transfer, and relearning, as compared with original learning, have been studied by investigators of learning in animals and in adult subjects. One of the principal motives of the present investigation is a desire to discover whether or not the principles and laws derived from experimentation on learning in animals and adults are equally applicable to learning in children of kindergarten age and younger.

One objection that may be raised against some of the materials used in studying the learning process is that the response by which the learning is studied is in itself too complicated and involves too many factors to be considered an adequate means of studying how learning takes place. For example, typewriting has been used quite extensively as a means of studying progress in learning; it seems advisable to choose a more simple problem than the acquisition of skill in typewriting in making a study of the psychology of learning, since typewriting is an exceedingly complex process involving both mental and physical elements. In the present investigation, the aim was to use as simple material as possible and to have the response of the child as simple as possible.

There are various theories current as to how learning takes place. The theory that has received the widest recognition is the theory that learning goes on through a process of association, a connecting of stimulus and response. A stimulus is presented and a response given. Later presentations of this stimulus will call out the response connected with it. The method used in the study of learning reported upon here is that of the association reaction type of response. The materials, forms of presentation, standard and variant forms, and methods of learning were planned as means of studying by association reaction the factors in the learning process of young children that have been studied with animals or with adult subjects and to discover experimentally whether there are similarities or differences in the results found in the present investigation and those reported in the literature on learning.

Material

The material for this experimental study of learning through the process of association reaction consists of a series of twenty blocks and a series of twenty pictures. After the twenty blocks of geometrical shapes had been decided upon, simple outline pictures were drawn to represent objects that are in some way similar to the blocks. With one exception possibly, the pictures are of objects with which every child is familiar. Each picture suggests the block with which it is to be associated in the experiment, and this facilitates the formation of associations. The pictures were made with India ink on unruled index cards, 3 by 5 inches. The plan of having a certain similarity between block and picture was decided upon in order that the learning involved would be not too difficult for preschool children. The approach to the study of the problem was made through blocks and pictures because of the universal appeal that these have for young children.

The twenty blocks were devised in such a way that the complete series may be regarded as consisting of two parallel series arranged in approximate order of complexity, from the simpler to the more complex. Each block of Series II, blocks 11 to 20, is a modification, or variant, of the block that parallels it in Series I, blocks 1 to 10. The material was designed in this way purposely in order to allow for variations from the standard form of presentation and interchange of blocks associated with the pictures.

Figure 1 shows the parallel arrangement of the blocks; the child, however, sees the blocks, placed before him, according to the arrangement shown in Figure 2. Figure 3 shows the pictures in the order corresponding to the parallel arrangement of the blocks; it is also the order in which they are presented to the child. The pictures are placed before the child, as shown in Figure 4, instead of the blocks, but in the order of the blocks originally placed before him, for a check on learning in order to test the permanency of the associative bonds formed during the learning.

Forms of Presentation of Material and Methods of Learning

The material was presented according to three different forms and two methods of learning in order to investigate some of the important problems involved in the study of the learning process. The forms of presentation are designated as the standard form and the variant forms, the first, standard form interchanged, in which

the associations between the blocks and pictures as given in the standard form are interchanged; and the second, the single series form, in which the child learns one half of the material only, either Series I or Series II.

The methods of learning are by trials on successive days or by trials on alternate days.

STANDARD FORM

The form of presentation of blocks and pictures used with the largest number of children is referred to as the standard form. Figure 1 shows the order in which the child's responses are given when the twenty correct associations have been formed according to this method of presentation.

The material was presented to each child until he had attained three consecutive perfect scores of 20, or, if he had not made three consecutive perfect scores at the end of the twentieth trial, the test was discontinued. A large number of the children attained scores of 20 once or twice, and then their scores dropped 1 or 2 points. For this reason the criterion of three consecutive perfect scores was adopted as a measure of complete learning.

The blocks are placed upon a low table before the child in two rows in the prescribed order (Figure 2); in the first row are blocks 5, 8, 13, 17, 20, 3, 16, 9, 2, and 14, and in the second row are blocks 11, 19, 4, 15, 1, 6, 12, 7, 18, and 10. According to this arrangement, no block is next to, above, or below the one that precedes or follows it in the experiment. The child is seated at one side of the table in front of the middle blocks so that he can reach easily any one of the twenty. The examiner sits opposite the child (Figures 5, 6, and 7).

When the child and examiner are seated, the latter says, "See these blocks," and pauses slightly while she indicates the blocks upon the table, " and see these pictures," indicating the pack of twenty pictures that she holds in her left hand, arranged in numerical order as shown in Figure 3. "*One* of these blocks [The examiner points toward the blocks on the table and puts slight emphasis upon the words italicized here.] goes with *each* picture. I am going to tell you which block goes with each picture and then I want to see if *you* can give *me* the *right* block that goes with each picture." The examiner holds up, in the left hand, the pack of pictures with the first picture, a clock face, on top, and says,

"When I show you *this* picture, you must give me *this* block. [The examiner picks up the round block, block 1, with the right hand and holds it beside the picture of the clock face.] Remember [slight pause] this is the *block* that goes with this *picture.*" The examiner then replaces the block in its former position upon the table. Using the same procedure, the examiner goes through the complete set of twenty pictures and twenty blocks, being careful to replace each block in its correct position before showing the next picture. When the last block has been replaced upon the table, the examiner says, "Now it's your turn. Let's see if *you* can give *me* the right block that goes with *each* picture. Give me the block that goes with this picture," and the examiner holds up the first picture. The whole series of pictures is gone through in this manner, the examiner repeating, "Give me the block that goes with this picture," as each picture is shown, and each time replacing the block the child has handed to the examiner so that in each case the child must choose from the total number. It was found advisable, after the children had learned many of the associations and responded almost as quickly as a picture was shown, to discontinue saying "Give me the block that goes with this picture" each time a picture was shown, and to repeat it only at frequent intervals throughout the whole series. This was due to the fact that often a response had been given before the examiner had repeated more than a word or two of the phrase.

The method of learning by one group of children was by trials on successive days, by another group, on alternate days. Each child's record was begun on a Monday so that within the two groups there should be a comparable distribution of learning periods before Saturday and Sunday intervened.

Learning on Successive Days: Children Studied Individually

The majority of children who learned the material were given it according to the standard form of presentation on successive days. Their records were studied individually and as a group, since most of them fell within the five and one-half year age group and therefore afforded sufficient material for establishing an age norm for this form of presentation.

Learning on Successive Days versus Learning on Alternate Days: Children Studied by Pairs

It was decided to present the material on successive days to one group of children and on alternate days to another group of chil-

dren, since the problem of the effect of distribution of work periods and rest periods upon learning is one of the most important phases of the learning process and one that has been the subject of much investigation. In order that the records might be comparable, the children were paired on the basis of approximately the same mental age, height, and weight. One child of each pair learned the material according to the standard form, on successive days; the other child learned it also according to the standard form, but on alternate days. The records were compared in order to determine whether, for this type of learning, presentation of material on alternate days or on successive days resulted in greater economy of learning.

VARIANT FORMS

Two variant forms of presentation of the material were devised as means of approach to some of the factors involved in the psychology of the learning process that were not considered in the standard form of presentation.

Standard Form Interchanged

For the standard form of presentation interchanged the blocks are placed upon the table and the pictures presented as for the standard form (Figures 2 and 3). The object of interchanging the associations is to compare the learning by this method with the child's first learning and to study the factor of interference or transfer. When the first trial is to be given for learning the reversed or interchanged associations, the examiner says, "These are the same pictures and the same blocks, but now there is going to be a *different* block that goes with each picture." [Special emphasis is placed upon the word different.] "I am going to tell you which block goes with each picture, and then I want to see if *you* can give *me* the *right* block that goes with each picture." The examiner holds up, in the left hand, the pack of pictures, with the first picture, the clock face, on top and says, "When I show you *this* picture you must give me *this* block." The examiner picks up block 11 with the right hand and holds it alongside the picture of the clock face. "Remember, *now* [slight pause] *this* is the block that goes with *this* picture." The examiner then replaces the block in its assigned position upon the table. Using the same procedure, the examiner goes through the complete set of twenty pictures and twenty blocks, but this time the pictures of Series I are

shown with the blocks of Series II, and vice versa, the pictures of Series II are shown with the blocks of Series I.

Learning on Successive Days: Children Studied Individually.— The material was presented according to the standard form interchanged to a small group of children who had completed the learning according to the standard form of presentation, followed by a check on learning. The method of learning was by trials on successive days.

Single Series: Series I and Series II

When a child is given the total number of twenty pictures and twenty blocks to learn, that is, both Series I and Series II, the effect that the learning of Series I may have upon the learning of Series II is a factor that is not easily determined. Since Series I and Series II are so comparable, it may be that the learning of the first series facilitates the learning of the second series; on the other hand, the latter part of the material may be more confusing because of the number of blocks and pictures that precede, or a child, particularly one of the very young children, may become fatigued before the twentieth picture and block have been reached.

In order to study experimentally the problem involved, a number of children were paired according to comparable results upon a mental test, and to one child of each pair the blocks and pictures of Series I only were presented; to the other child, the blocks and pictures of Series II only were shown. Figure 8 shows the arrangement of blocks on the table when Series I only is being learned by the child and Figure 9 shows the arrangement of blocks on the table when Series II only is being learned. It is to be noted that the block of each series has relatively the same position as the block with which it is paralleled. For example, the first block of Series I and the first block of Series II are the second from the left on the lower rows of blocks, and the third block of each series is the middle block in the upper row in each grouping. The directions are the same as for the standard form.

Learning on Successive Days: Children Studied by Pairs.— Learning for the single series was on successive days only. The results of each child's trials were compared with the results of the child with whom he was paired in order to study any differences that might occur between learning on Series I and learning on Series II, that is, when results from comparable material are compared on comparable children.

Check on Learning

CHECK ON LEARNING OF STANDARD FORM

When three consecutive perfect scores have been attained on the standard form, one additional trial of a different type is given as a check upon the learning. The learning situation is now reversed. The examiner places the pictures upon a low table in two rows, as shown in Figure 4, in the order corresponding to the prescribed arrangement of the blocks as shown in Figure 2. The blocks are then shown to the child, one at a time, in the order shown in Figure 1. When beginning this part of the experiment, the child stands at the table in front of the middle pictures. The reason for having the child stand is that the pictures extend sufficiently far toward his right and left to necessitate his walking up and down in order to locate the required picture. The smaller child would probably be unable to reach the pictures at the extremes of the two rows if he were seated. When the child has taken his position before the pictures arranged on the table, the examiner says, "These are the same pictures and the same blocks, but now *you* are going to have the pictures and *I* am going to have the blocks. When I show you a *block,* you point to the *picture* that goes with the block." The examiner has the twenty blocks arranged in order in four equal piles of five blocks each and picks up block 1 from the top of the first pile. As the block is held up before the child, the examiner says, "Show me the *picture* that goes with this *block.*" The whole series of blocks is gone through in this way, the examiner repeating the last sentence as each block is presented to the child. One trial only is given in this manner. Since this reversal of the learning situation is used simply as a check on learning, it is not counted in the total number of trials required for complete learning. In order that this record may stand apart from the records of daily trials of the learning, it is marked "Picture-block" at the top of the score sheet used for this trial. The number of the trial on the record of the third successive score of 20 is counted as the number of trials necessary for complete learning and this number is used for comparing individual records, for obtaining averages by groups, mental ages, and by sexes, and in the various correlations.

CHECK ON LEARNING OF VARIANT FORMS

For the check on learning of the variant form referred to as the standard form interchanged, the arrangement of the pictures upon the table and the procedure are the same as for the check on learning of the standard forms. Now, of course, when the examiner shows the blocks of Series I, the child responds by pointing to the pictures of Series II and, vice versa, when the blocks of Series II are shown, the examiner responds with the pictures of Series I.

For the check on learning the single series form, Series I only or Series II only, the pictures (Figures 10 and 11) are in the same position as the blocks with which they correspond and here, as in the arrangement of the blocks for learning Series I or Series II only, the pictures of each series have relatively the same position.

RELEARNING AFTER AN INTERVAL OF ONE YEAR

Several investigations that deal with the learning process have included retention tests on material learned under experimental conditions from a few months to a few years previous to the giving of the retests. The majority of these studies have dealt with the retention of learning in which the problems have involved the acquisition of motor skill, such as ball tossing, mirror tracing, or typewriting. In the present investigation, a small number of children who had completed the learning of the entire series of twenty pictures and twenty blocks according to the standard form were available one year later and were given the material again in order to compare each child's results on learning with his results on relearning after an interval of one year.

RECORDS OF DATA

RECORD SHEET

Results of each trial are kept on a record sheet; the form includes spaces for the name of the subject, date of test, chronological age, mental age, and the number of the trial; outlines of the twenty blocks arranged as for the standard presentation (Figure 1), and a space, the lower half of the sheet, headed "Observations." When a child hands the correct block to the examiner, the latter places a plus sign upon the corresponding outline on the record sheet. When an incorrect block is given, the examiner draws it upon the score sheet beside the outline of the block that should have been given. In the analysis of the data, it is necessary to

have this exact record of the incorrect responses instead of simply the indication of an error by a minus sign, in order to determine not only how many errors are made but exactly what errors are made, which blocks are most frequently confused, and to determine the order of difficulty of the formation of the associations.

SCORES

The method of scoring the individual tests is 1 point for each correct response; thus the perfect score is 20, except for the variant form of learning one series only, for which form the score is 10. The results of the experiment are scored on the basis of the number of trials required for complete learning and it is this number of trials that is used throughout the statistical analysis. The number of trials necessary for complete learning is understood to be the number of the trial on which the third perfect score is attained. The check on learning is not included, since this is not an intrinsic part of the learning situation. In the tables in which the actual score on each trial is given, the numbers italicized denote the score on the check on learning and are not to be included in computing the number of trials required for complete learning.

OBSERVATIONS

The examiner records anything that may be of value in interpreting the results. Usually a few minutes are necessary after each trial for the examiner to write up these observations. Sometimes a few words in regard to many of the observations are jotted down while the child is making responses, but they are always enlarged upon immediately after the completion of each trial. Under "Observations" are noted the type of the child's response, whether it is quick or slow, whether the child picks up just any block, a block near at hand, or seems to be searching for a particular one, and whether one or both hands are used, if only one, which one. It is particularly important to record comments made by the child during the experiment. Very frequently a child mentions and points out the similarity of block and picture. Many children remarked upon the ease or difficulty of finding certain blocks. Sometimes, at the end of a trial, a child made comments on the situation as a whole. A very few of the children localized the position of some of the blocks, and, when nearly all associations had been learned, reached directly with the right or left hand

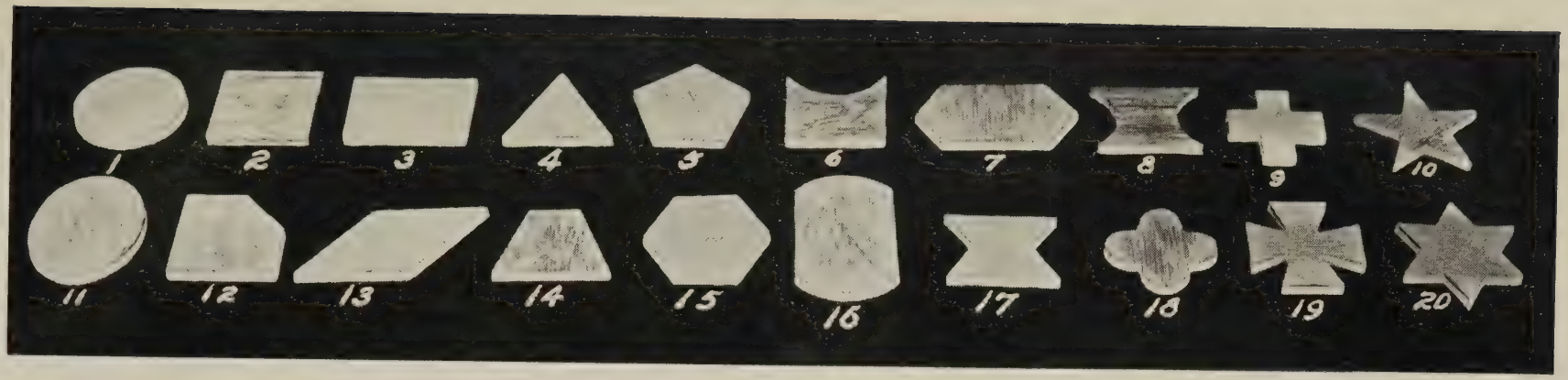

Fig. 1. The twenty blocks in the association reaction learning experiment placed so as to show the parallel arrangement of the two series, Series I, blocks 1 to 10, and Series II, blocks 11 to 20.

Fig. 2. The arrangement of the blocks as placed before the child for the standard form of presentation and for the standard form interchanged.

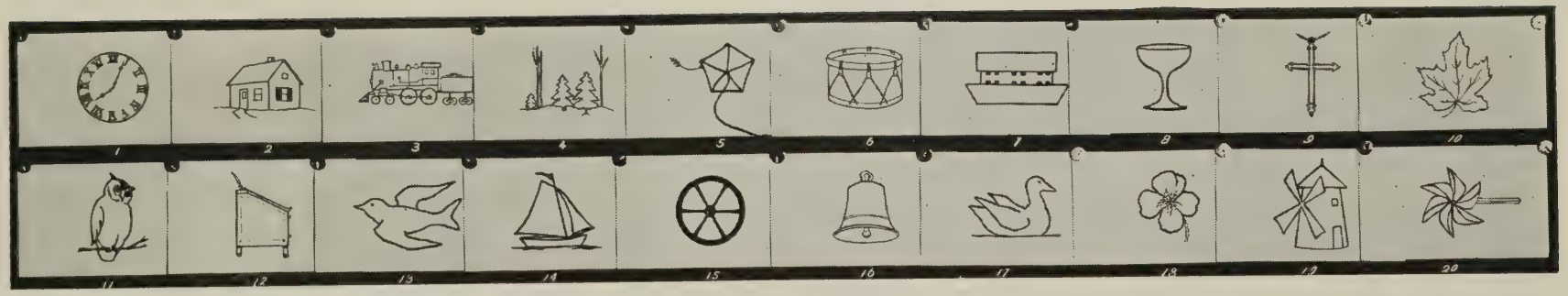

Fig. 3. The order of the twenty pictures as presented to the child for association with the blocks for the standard form of presentation and for the standard form interchanged.

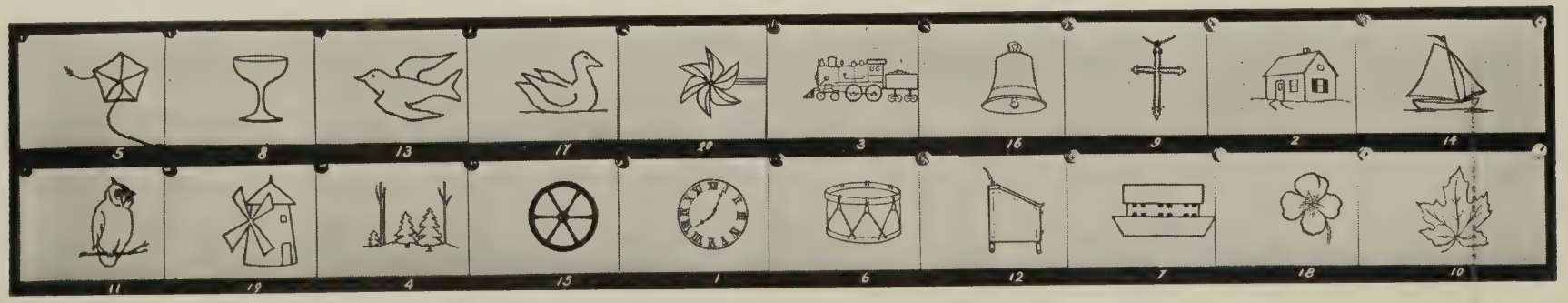

Fig. 4. The arrangement of the pictures as placed before the child for the check on learning, the arrangement corresponding to that of the blocks in Figure 2.

Fig. 5. Child being shown the series of twenty pictures and the blocks that are to be associated with each picture.

Fig. 6. Child responding with a block when the examiner shows a picture.

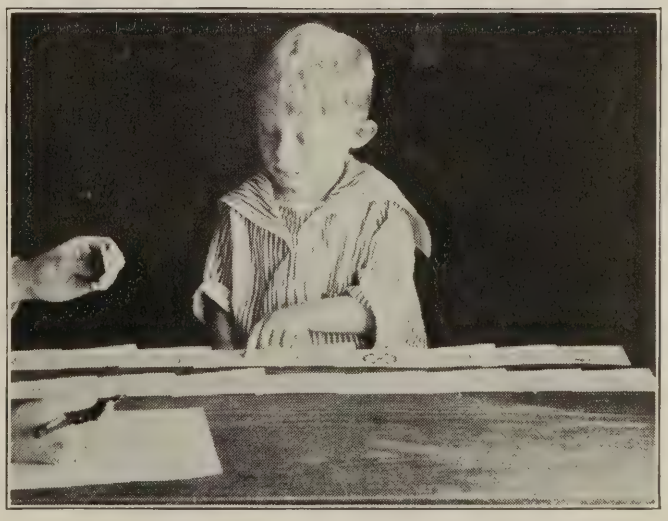

Fig. 7. As a check on learning, the child responds with a picture when a block is shown.

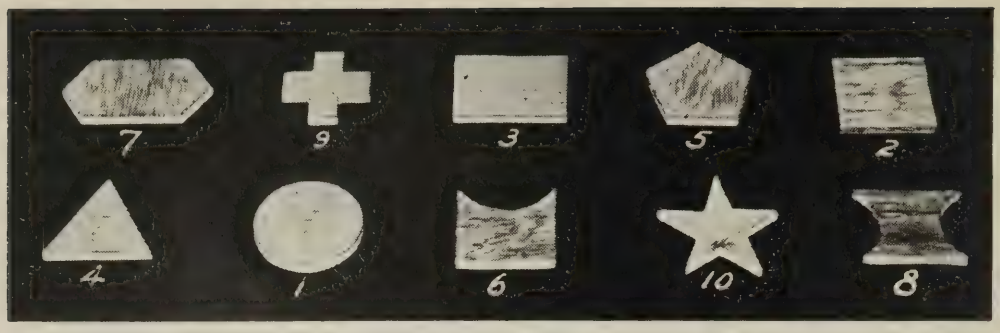

Fig. 8. The arrangement of the blocks as placed before the child for the single series form of presentation when Series I only is to be learned.

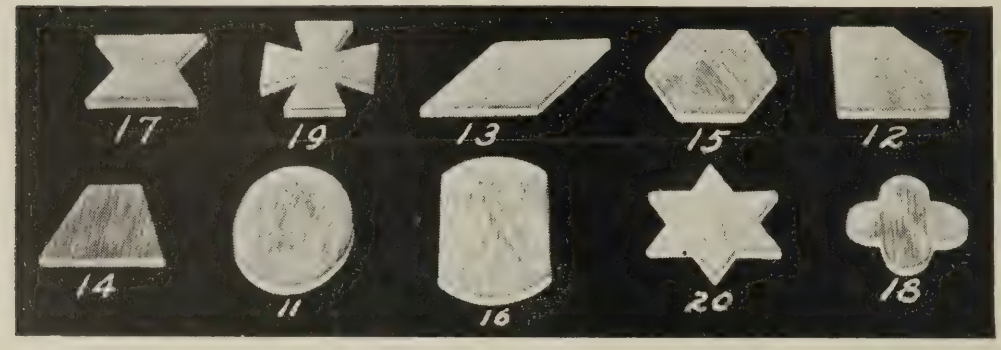

Fig. 9. The arrangement of the blocks as placed before the child for the single series form of presentation when Series II only is to be learned.

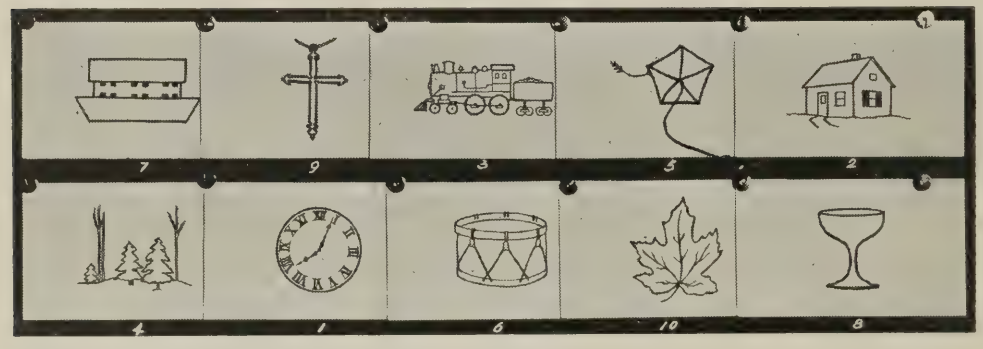

Fig. 10. The arrangement of the pictures as placed before the child for the check on learning when Series I only is used, the arrangement corresponding to that of the blocks in Figure 8.

Fig. 11. The arrangement of the pictures as placed before the child for the check on learning when Series II only is used, the arrangement corresponding to that of the blocks in Figure 9.

for the correct block, according to its position on the table. The child's interest and attention during the examiner's presentation of the series of blocks and pictures and during the child's performance were recorded. An interesting point noticed in many records was the confusion either between or among the pictures, or between or among the blocks. In several instances, this confusion persisted for several successive trials, before it was eliminated and in the case of a few of the children, the confusion reappeared after the correct response had been made once, twice, or more times. The responses before which a child showed considerable hesitation were indicated on the record sheet. A large number of the children named aloud the pictures or the blocks, or both, while the examiner was showing the material to the child or while the child was handing the blocks to the examiner. Such general items as these and others that refer to specific children only were recorded on their respective score sheets.

CUMULATIVE RECORD CARD

A cumulative record card was used in assembling data from the various trials of each child. This record card contains spaces for recording the name of the subject, date of birth, chronological age at the time of the learning experiment, date of Stanford-Binet examination with chronological and mental ages, intelligence quotient, name of examiner, and dates on which the learning experiment is begun and finished. The forms and methods by which the material may be learned are listed. They are checked on each child's record card to indicate the form and method used on his trials, the number of the trial on which the first perfect score is attained, and the number of the trial on which the third successive perfect score is achieved. The card contains also a space for recording the number of days absent and a list of psychological tests whose scores are recorded for purposes of correlation with the number of trials necessary for learning the associations of pictures and blocks.

Possibilities for Further Study

The material used in this investigation lends itself readily to adaptation to various forms of presentation and to various methods of learning. In addition to the forms of presentation used in this investigation, the block-picture, or standard, form of learning the material, the picture-block form, or check upon learning, the re-

versed, or interchanged associations, and learning only Series I or Series II, other forms of presentation have been planned but not used. One of these variations in presentation of material for learning will consist in having the child learn the material according to the picture-block form of presenting the blocks one at a time to the child and having him respond with the pictures. The check in this case will, therefore, consist of one trial according to the standard form of presentation of material. The material might be presented in another form by arranging the blocks in the same order on the table as for learning according to the standard form, but shuffling the cards before each presentation so as to have the pictures mixed instead of in the same order for each trial. Conversely, the pictures could be presented in the original order as for the standard form of learning, and the blocks placed upon the table in mixed order. These suggested methods of procedure should result in information upon the effect on learning of presentation and sequence of material. It has been planned also to devise a means of presenting the material according to a nonverbal form so that it may be used with foreign-born and deaf children. This form could be used with Series I only or Series II only with very young children. In further work with this material, other variations of methods of procedure will suggest themselves, no doubt, as means of studying various phases of the learning process.

CHAPTER II

SUBJECTS OF THE EXPERIMENT

The material of this experiment was given to 203 children according to one or two of the forms of presentation and one or two of the methods of learning. The records of twenty-three of the total number of children could not be included in the analysis of data because the learning had been discontinued on account of absences (ten children); or because the child had failed to learn completely the material by the end of the twentieth trial and the experiment was, therefore, discontinued (eleven children); or because the record of complete learning was not of value since the children with whom they were to have been paired were absent the entire time that the learning experiment was being conducted (two children). The 180 children on whose records the study is based were secured from two sources, the Preschool Laboratories of the Iowa Child Welfare Research Station, State University of Iowa, and five public school kindergartens of a small city in Iowa.

Children in the Preschool Laboratories

Seventy of the 180 children were in the Preschool Laboratories of the Iowa Child Welfare Research Station. The Preschool Laboratories comprise two groups of children, one group, designated the Preschool Laboratory, includes children whose chronological age range is from two to five years, and another group of children, known as the Junior Primary Group of the University Elementary School, includes children whose chronological age range is from five to six years. All of the junior primary children who were subjects of the experiment fell within the five and one-half-year age group, that is, the chronological age range of these children was from five years and no months to five years and six months.

Children in Five Kindergartens

One hundred ten children were in five kindergartens of the public schools of Mason City, Iowa. The kindergarten children who learned the material according to the standard form of presentation were selected so as to be comparable in chronological age

to the junior primary children. The experimental work on learning was done with the kindergarten children in the spring shortly before the close of the school year. As these children, with few exceptions, had passed the fifth birthday before entering kindergarten, approximately seven months previously, it was necessary to select the children who were younger chronologically at the time of entering since those who were older were a few months too old to be grouped with the junior primary children. This factor of selection may possibly have eliminated the pupils who were not so bright, since the brighter pupils are usually the younger. Some of the kindergarten children who were subjects of the variant form of learning one series of the material only were a few months older than those selected for learning the material according to the standard form, but no child was older than six years and five months, the upper limit of the six-year-old group.

Range of Chronological Ages

In this study, two years of age refers to children who range in chronological age from one year and six months to two years and five months; three years, from two years and six months to three years and five months; four years, from three years and six months to four years and five months; five years, from four years and six months to five years and five months; and six years, from five years and six months to six years and five months.

The chronological age distribution of the 180 children who completed the learning was from two years and two months to six years and five months. There are too few subjects at the lower ages for statistical analysis so this is limited to the children of the five and one-half-year age group, that is, from five years and no months to five years and six months, at which age the majority of children are found. One child only falls in the two-year age group and three children only fall in the three-year age group.

Range of Mental Ages

The mental age referred to here is that derived from the Stanford-Binet mental examination. Each of the 132 children who learned the material according to the standard form of presentation by various methods of learning was given an individual Stanford-Binet mental examination. The children in the Preschool Laboratories are given Stanford-Binet examinations as a part of

the regular routine. The kindergarten children used as subjects had not been given Stanford-Binet examinations previous to this study. The examiner therefore gave Stanford-Binet examinations to the sixty-four kindergarten children to whom the material was

TABLE 1
Distribution of 180 Children according to Form of Presentation of Material and Method of Learning and Relearning

Children	Groupings	Total number of children	Form of presentation					Relearning	
			Standard	Variant				Standard form of presentation	
				Standard form interchanged	Single series				
					Series I	Series II			
			Method of learning						
			Successive days	Alternate days	Successive days	Successive days		Successive days	Alternate days
Preschool	Individual	32	32		7			1	
Junior primary	Individual	16	15	1	8				
Junior primary	Paired	22	11	11				5	7
Kindergarten A	Individual	35	35						
Kindergarten B	Individual	15	15						
Kindergarten B	Paired	16				8	8		
Kindergarten C	Individual	12	12						
Kindergarten C	Paired	14				7	7		
Kindergarten D	Paired	12				6	6		
Kindergarten E	Paired	6				3	3		
		180	120	12	15	24	24	6	7

presented according to the standard form. The forty-eight to whom the material was presented according to the variant form, known as the single series form, were not given Stanford-Binet examinations. The only mental test records of these forty-eight children were scores on the Detroit kindergarten test.

The only two-year-old child in the entire group of subjects who completed the learning had a mental age of three years and eight months. It is the lowest mental age found among the children. The highest mental age, eight years and eight months, was that of a junior primary boy whose chronological age was five years and eight months. This mental age range from three years and eight

months to eight years and eight months includes the 132 children who learned the material according to the standard form of presentation by the various methods of learning.

Distribution according to Presentation of Material

The material was presented on successive days according to the standard form to 120 children, thirty-two preschool, twenty-six junior primary, and sixty-two kindergarten children. The material was presented on alternate days according to the standard form to twelve of the junior primary children. The material was presented on successive days, according to one of the variant forms, to forty-eight kindergarten children; twenty-four were given Series I only and twenty-four Series II only. The other variant form, learning of interchanged learned associations, was presented to seven preschool children and eight junior primary children, all of whom had learned the material according to the standard form on successive days. One preschool and twelve junior primary children relearned the material after an interval of one year, according to the method of learning it originally, seven on alternate days and six on successive days. Table 1 shows the distribution of the children who completely learned the material.

The number of children on any one form, or method, is not sufficiently large to allow standardization of results according to chronological or mental age groups, except at the five and one-half-year age on the standard form of presentation of material on successive days.

CHAPTER III

RESULTS OF EXPERIMENTAL STUDY

An understanding of how the children formed the required associations involved in this association reaction experiment was based upon an analysis of the results in regard to the cues used by the children in forming associations, the order of difficulty, whether the confusions were due largely to confusion between pictures or to confusion between blocks, and whether there was interference or transfer when the learned associations were interchanged. Factors such as distribution of work and rest periods, learning only one half of the material, and relearning were found to have considerable effect upon the length of time required for learning. The quantitative results derived from the children's records were supplemented by comments of the children during the experiment and by observations of the examiner at the time of the child's responses. Statistical results are based mainly upon the standard form of presentation, since the number of children on each of the variant forms is insufficient to justify statistical treatment of the data. The ages of the children are scattered over such a range that at only one age, five and one-half years, are there enough children to formulate a tentative norm for an age group.

Each of these factors and the interpretation of the part played by them in the association reaction type of learning will be taken up and discussed separately.

Criterion of Learning

In giving the directions for learning the material used in this experiment, it was stated that the criterion of learning is three consecutive perfect scores of 20. If the child did not attain this record by the end of the twentieth trial, the experiment was discontinued. Many of the children attained one score or perhaps two consecutive scores of 20, but failed to score 20 on the following trial. Sometimes the decrease was a matter of 1 point only, but in the majority of instances the decrease in score was 2 points, and in a very few cases, 3. The reason for the drop of 2 points was that the decrease in score was due to a confusion of two of the

parallel forms. For example, some of the confusions that occurred most frequently were responding with the six-pointed star when the five-pointed star should have been given, and later, responding with the five-pointed star instead of the six-pointed; similarly, the regular pentagon and regular hexagon were confused.

In some of the studies found in the literature on the psychology of the learning process, a subject has been considered to have learned given material when he was able to respond with one perfect trial. The results of the present investigation show that one perfect performance is inadequate as a criterion of learning. In many instances, at the time the subject is able to achieve one perfect trial the learning of the material has just reached the threshold of learning. The associative bonds involved in the process of learning are not sufficiently strong to warrant a similar performance on successive trials. It was decided arbitrarily before beginning the work on this investigation to set three successive perfect trials as one of the criteria of learning. Results indicate that when the child has given three successive perfect responses the material may be regarded as having been completely learned.

Table 2 shows the number and distribution of children who attained three successive scores of 20 (perfect) and those who attained one score of 20, or two successive scores of 20, then a score less than 20, and later three successive perfect scores. One child who had scored 20 on two successive trials made a score of 18 on the following trial, and maintained this record for six consecutive days, followed by a score of 19, and then attained three consecutive perfect scores. The continuance of score 18 was due to a persistence of the confusion of the regular pentagon and regular hexagon blocks. This child secured her first perfect score on the ninth trial, but it was not until the twentieth trial that she had attained the third successive score of 20. Another child who had attained one score of 20, on the following day scored 17 only; this was followed by a score of 20 on each of the next two days, then 18 on the two following days, after which three successive scores of 20 were achieved. In this case, the unstable associations were in connection with blocks 10 and 20 and 8 and 17. The first score of 20 had been secured on the eighth trial, but it was not until the sixteenth trial that the third successive score of 20 was secured.

The third successive perfect score was followed by the check upon learning. So few of the children failed to make a perfect score

on the check that it is believed that an increase in the number of successive perfect scores fixed as one of the criteria of learning would not improve the results. On the other hand, two successive

TABLE 2
Distribution of 180 Children according to Attainment of Perfect Scores

Children	Groupings	Total number of children	Three successive perfect scores			Perfect scores followed by decrease		
			Form of presentation					
			Standard form	Variant		Standard form	Variant	
				Standard form interchanged*	Single series		Standard form interchanged*	Single series
Preschool	Individual	32	24	6		8	1	
Junior primary	Individual	16	15	8		1		
Junior primary	Paired	22	15	3		7		
Kindergarten A	Individual	35	30			5		
Kindergarten B	Individual	15	14			1		
Kindergarten B	Paired	16			14			2
Kindergarten C	Individual	12	12					
Kindergarten C	Paired	14			13			1
Kindergarten D	Paired	12			11			1
Kindergarten E	Paired	6			6			
		180	110	17	44	22	1	4

* Children to whom the material was presented according to the standard form interchanged had learned it according to the standard form.

perfect scores were quite frequently followed by a decrease in score. Therefore, the validity of the criterion of three successive perfect scores, although decided upon arbitrarily, seems justified by results.

ABSENCES AS A FACTOR IN LEARNING

In discussing the method of presentation of material used in this study of learning, it was stated that each child's record was begun on a Monday in order to have the same number of trials before Saturday and Sunday intervened. Theoretically, this plan would give the same relationship between work periods and rest periods for each child so that the records among the children in each of the groupings would be comparable. As would be ex-

pected, a certain number of absences occurred during the time when some of the children were being used as subjects of the experiment. Since the effect of absence on the child's record would be a factor that can not be measured, and since in any learning situation the distribution of work periods and rest periods is of great importance and must be taken into consideration in an analysis of the data, particularly in the comparison of the record of one child with that of another, it was arbitrarily decided before beginning this investigation to discontinue work with any subject who was absent for more than three consecutive days. Some of the children had a total number of absences that amounted to more than three days, but no child's record that was used in this report shows an absence of more than three consecutive days.

In one of the two investigations that are the only published work on learning of young children,[159] the children were given trials once a day five days a week, just as in the case of the children who learned the associations of pictures and blocks according to the standard form of presentation of this material. The authors of this investigation, a card sorting experiment, state, "For about one-third of the children there was an interval of approximately one month between the tenth and eleventh trial which resulted in a decrease of score in some cases." In investigations of learning in which a special study has been made of the influence of distribution of practice periods, particular emphasis is placed on the consideration that must be given to intervals between work periods. The comparison of the learning accomplished by one third of the children who were subjects of this experiment who had an interval of approximately one month between the tenth and eleventh trials (or just at the middle of the total length of practice time, since each child was given twenty trials), with the learning accomplished by two thirds of the subjects who did not have this one month interval between these two practice periods can hardly be expected to give reliable results. In regard to the effect of a month's absence on the practice curve for card sorting, the authors admit that there was a decrease of score in some cases, but conclude the discussion with a statement that "this decrease was in general no greater than when only an occasional day was lost." The actual amount of decrease is not stated; neither is it known to how many of the total number of fifty-six children the reference is made by the statement that the one month's absence "resulted in a decrease of

score in some cases.'' In fact, the data given regarding effect of absences on the learning involved is too general; and in the tabulated results, no indication is made as to which of the children had this prolonged absence so that one does not know whether or not to interpret all the decreases in scores from the tenth to the eleventh trial as due to this absence, or to specific conditions that influenced the child's learning at that particular time so as to cause a decrease in score.

Of the 180 children who formed completely the twenty associations involved in the learning experiment herein reported, 126 had not one day's absence. Fifty-three children were absent from one to five times and one child was absent seven times, which was the maximum, that is, among the total number of subjects under discussion, there are almost two and one-half times as many children who did not miss a trial due to absence as the total number of children who had from one to seven days' absence. The influence of absence on progress in learning has, therefore, been reduced to a minimum by discontinuing the experiment with the subjects who were absent more than three successive days. The complete record of number and distribution of absences for each form in which the material was presented is shown in Table 3.

Quantitative and Qualitative Analysis of Data

Material

The material devised for this experiment appealed to the children and interested them very much. The examiner always referred to the material as a ''game'' when speaking to the children, and to the experimental situation as ''playing the game.'' Many of the children said that they liked to play with blocks and that they liked ''the block game'' as they called it, although the examiner did not so name it. It is interesting to note that every child who referred to the learning material as a whole used the blocks as a means of designating it. Often when the examiner went into the group room, a child who had already had trials on the material jumped up and asked the examiner, ''Am I going to play with your blocks?'' or ''Can I play the block game now?'' During the time when the material was being used, the children asked many questions about the blocks, such as ''Who made these blocks?'' ''Where did you get these blocks?'' ''Can I take these

TABLE 3

Number and Distribution of Absences of 180 Children according to Form of Presentation of Material and Method of Learning

Children	Groupings	Form of presentation	Method of learning	Total number of children	Absences, days							
					0	1	2	3	4	5	6	7
Preschool	Individual	Standard	Successive days	32	15	5	6	2	2	1		1
Junior primary	Individual	Standard	Successive days	15	12	2				1		
Junior primary	Individual	Standard	Alternate days	1	1							
Junior primary	Paired	Standard	Successive days	11	7	4						
Junior primary	Paired	Standard	Alternate days	11	9	2						
Kindergarten A	Individual	Standard	Successive days	35	27	4	2	2				
Kindergarten B	Individual	Standard	Successive days	15	9	5	1					
Kindergarten B	Paired	Single series	Successive days	16	13	2		1				
Kindergarten C	Individual	Standard	Successive days	12	8	4						
Kindergarten C	Paired	Single series	Successive days	14	8	3	3					
Kindergarten D	Paired	Single series	Successive days	12	12							
Kindergarten E	Paired	Single series	Successive days	6	5	1						
				180	126	32	12	5	2	2		1

blocks home?'' ''I wish I had some of the blocks at home.'' ''How did you make these blocks?'' ''Who gave you these blocks?''

When the children were not actually seeing the material, the pictures seemed to play a much smaller part in their idea of the ''game'' than the blocks. None of the children while not in the examining room referred to ''the picture game.'' It was always ''the block game.'' This is due probably to the fact that during the learning, the child responds by picking up each block and handing it to the examiner. The child, therefore, handles the blocks and his attention is directed more to them. The pictures brought out comments during the various trials. These comments were more likely to be in regard to the pictures as connected with the blocks, however, than to the pictures as pictures; whereas, in the case of the blocks, the blocks as blocks interested the children. A few of the children asked the examiner, ''Did you draw these pictures?'' ''Who made these pictures?'' or commented upon the object represented in the picture. When the pictures were mentioned apart from the similarity of blocks and pictures the comments made were generally in regard to the esthetic effect or affective tone produced by the picture upon the child. The comment was made very frequently in regard to picture 18, ''That's a pretty flower,'' ''I like that flower.'' The picture of the windmill, picture 19, was another pleasing one. The picture of the flower and the picture of the windmill called forth more comments of this type probably than any other of the pictures. ''I think that's a pretty little windmill,'' ''I like that windmill,'' or a similar remark was made quite frequently.

Almost every child made some comment upon the similarity of certain of the pictures and their corresponding blocks. The resemblance between pictures and blocks was evident enough for even the youngest of the children to observe and comment upon certain of the resemblances. Frequently a child pointed out a resemblance and then added a comment that no doubt helped to fix the association in his mind. For example, several of the preschool children who were learning the material shortly after Christmas remarked upon the similarity of block 3 and the coal car of the train picture with which this block is associated, and remarked, ''That's like my choo-choo train too'' or ''I got one like that for Christmas.'' With many children there was a tendency to repeat during each successive trial comments made on the first few trials

regarding the similarity of certain blocks and pictures. The only picture that seemed to be of an object unrecognizable to some of the children was the picture of the old-fashioned writing desk. When a child asked the examiner what the picture was, it was considered permissible to tell him. The fact that this object was more likely than any other to be unknown to the children did not interfere with their ability to form the required association between the picture of the desk and block 12, since very few errors were made on this. In this case the obvious resemblance that serves as a basis for the child's formation of the associations seems to be a good index to the fact that the children were able to pick out correspondence between block and picture, even in case the object represented in the picture was not recognized by the child. One small boy during each of his daily trials ran his finger along the sloping part of block 12 and immediately after ran his finger along the corresponding part of the picture, the slanting writing surface of the desk, and commented that they were "just alike," or "just the same." After several days of this repetition the examiner pointed to the picture and asked the child, "What is that? What is that a picture of?" The child responded without any hesitation, "An ice box." Nevertheless, the association of the correct block with this picture had been made from the first trial and the child continued to respond correctly each time until learning had been completed.

FORMS OF PRESENTATION OF MATERIAL AND METHODS OF LEARNING

Standard Form

The 132 children who learned the material according to the standard form of presentation were distributed as follows:

Children	Groupings	Method of learning	Number of children
Preschool	Individual	Successive days	32
Junior primary	Individual	Successive days	15
Junior primary	Individual	Alternate days	1
Junior primary	Paired	Successive days	11
Junior primary	Paired	Alternate days	11
Kindergarten A	Individual	Successive days	35
Kindergarten B	Individual	Successive days	15
Kindergarten C	Individual	Successive days	12
			132

Among the 120 children who learned the material on successive days were eleven children who were paired off for the purpose of

comparing their learning with that of the children who learned the material on alternate days. In the analysis of the data, the records of the children of the pairs who learned the material by the standard form of presentation on successive days may be included both with those of the children who learned the material on successive days and were not paired, and with those of the children with whom they were paired who learned the material on alternate days. The thirteen children who relearned the material after an interval of one year are included in the total 132, six having learned it on successive and seven on alternate days.

Learning on Successive Days: Children Studied Individually.— The 120 children who are discussed here include these groupings:

Children	Groupings	Method of learning	Number of children
Preschool	Individual	Successive days	32
Junior primary	Individual	Successive days	15
Junior primary	Paired	Successive days	11
Kindergarten A	Individual	Successive days	35
Kindergarten B	Individual	Successive days	15
Kindergarten C	Individual	Successive days	12
			120

The few children who learned the material on successive days and were paired with children who learned it on alternate days were included in this group since the form of presentation and method of learning are identical with those of the children who were not paired.

For the thirty-two preschool children who learned the material according to the standard form of presentation and the method of learning on successive days, the range of trials necessary for complete learning was from five to twenty; for the twenty-six junior primary children the range was from four to fourteen; and for the sixty-two kindergarten children the range was exactly the same as for the junior primary children. The junior primary group and the kindergarten group each includes one child only who learned the material in four trials and one only who required fourteen trials in which to complete the learning. In each of these groups, the majority of children required from five to nine trials in order to form correctly the twenty associations.

Table 4 shows for each group of children the average number of trials required for learning for various forms of presentation and for various methods of learning. The records on the standard

TABLE 4
Average Number of Trials Required for Learning on Various Forms of Presentation of Material and Methods of Learning

Form of presentation and method of learning	Preschool		Junior primary		Kindergarten			
					Standard form		Variant form	
	Number of children	Average number of trials	Number of children	Average number of trials	Number of children	Average number of trials	Number of children	Average number of trials
Standard form of presentation								
Learning on successive days	32	13.26	26	7.42	62	7.02		
Learning on alternate days			12	5.75				
Variant form of presentation								
Series I. Learning on successive days							24	5.61
Series II. Learning on successive days							24	5.79
							48	5.75

form of presentation of material on successive days include those of children from the Preschool Laboratories, Junior Primary Group, and from three of the five kindergartens. The average number of trials for thirty-two preschool children is 13.56; for twenty-six junior primary children, 7.42; and for sixty-two kindergarten children, 7.02. It is interesting to note that the average number of trials required for learning by the preschool children is reduced almost 50 per cent by the junior primary children and the kindergarten children. The average number of trials for junior primary and for kindergarten children is almost identical, the difference being 0.4. Combining the number of junior primary and kindergarten children gives a total of eighty-eight, five and one-half years of age, whose average number of trials is seven for complete learning of the material when given according to the standard form of presentation on successive days.

Learning on Successive Days versus Learning on Alternate Days: Children Studied by Pairs.—For a comparison of the number of trials required for complete learning when the material was presented on successive days and the number of trials required for complete learning when the material was presented on alternate days, twenty-six children of the junior primary group were paired on the basis of similarity in regard to Stanford-Binet mental age, height, and weight. It was hoped that by having only a slight difference on three variables between the children of each pair that comparable results would be obtained. After the children had been paired, one child of each pair was given the association reaction learning material according to the standard form of presentation, on successive days; the other child was given the same material according to the standard form of presentation, on alternate days. Due to absences it was necessary to discard the records of two of the paired children who were learning the material on successive days and of one of the paired children who was learning it on alternate days.

The total number of paired children was reduced, therefore, to twenty-two. The record of the child who learned the material on alternate days and was now without a pair was retained, however, and used for study by individual grouping and for the study of relearning.

Table 5 shows the comparison of scores of junior primary children paired on mental age, height, and weight for learning on

TABLE 5

Comparison of Scores of Junior Primary Children Paired on Mental Age, Height, and Weight for Learning according to Standard Form of Presentation of Material on Successive Days and on Alternate Days

Child	Sex	Differences			Method of learning, Days	Learning															Total number of trials
		Mental age, Months +	Height, Cm. +	Weight, Kg. +		Trial															
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
						Score															
1	F			1.3	Successive	14	19	17	18	20	19	20	20	20	*20**						9
1a	F	1	1.0		Alternate	17	19	20	20	20	*20*										5
2	F		1.8		Successive	9	16	17	20	20	19	20	20	20	*20*						9
2a	F			0.7	Alternate	10	17	20	20	20	*20*										5
3	F				Successive	13	17	20	20	19	20	20	19	20	20	20	*20*				11
3a	F		2.3	0.95	Alternate	18	19	20	20	20	*20*										5
4	F		2.8		Successive	17	20	20	20	*20*											4
4a	M			0.75	Alternate	8	16	20	20	20											5
5	M				Successive	13	17	16	20	20	19	19	20	20	20	*20*					10
5a	M		2.0	5.0	Alternate	13	16	18	20	19	20	20	20								8
6	F		1.2	0.6	Successive	9	12	17	18	19	20	20	20	*20*							8
6a	F	1			Alternate	17	17	18	20	20	20										6
7	M	2	1.7		Successive	6	11	14	19	19	20	20	20	*20*							8
7a	M			1.65	Alternate	6	14	20	20	20	*17*										5
8	F	2	0.9		Successive	12	17	18	19	20	18	20	20	20	*20*						9
8a	M			0.85	Alternate	8	15	19	20	20	20	*20*									6
9	F	1			Successive	8	14	19	20	20	20	*20*									6
9a	F		1.0	0.40	Alternate	9	12	19	20	20	20	*20*									6
10	F				Successive	6	12	9	16	17	16	19	17	17	20	19	20	20	20	*20*	14
10a	M	2		0.26	Alternate	8	12	18	20	20	20										6
11	M	3		2.17	Successive	5	9	15	17	17	20	20	20	*20*							8
11a	M		4.1		Alternate	10	13	18	18	20	20	20	*20*								7

Range of mental age: 6 years, 5 months to 7 years, 6 months; range of height: 104.2 to 117.5 cm.; range of weight: 15.0 to 23.75 kg.

* Italics denote score on check on learning.

successive days and learning on alternate days. With two exceptions, pairs 5 and 11, the close resemblances of these paired children is remarkable considering that three variables are involved. Pairs 5 and 11 were included, however, because in both cases the greater differences are between height and weight rather than between mental age scores, which seem to be the most important of these three factors in a problem involving learning. The records of height and weight were included simply to have the children as comparable as possible, but no attempt is being made to show the influence of height and weight as factors in learning.

A comparison by pairs in Table 5 of the total number of trials required for complete learning shows that, with one exception, the child of each pair who learned the material on alternate days learned it in fewer trials than the child who learned it on successive days. The record of pair 4, in which the exception occurs, shows that the child of this pair who had the material presented on successive days learned it completely in four trials and the child with whom she was paired learned the material in five trials on alternate days. The child who required four trials only is not only an exception among this group used for comparison of learning on successive days with learning on alternate days, but also an exception among the twenty-six junior primary children who learned the material on successive days, whereas the record of the child with whom she is paired who learned it in five trials when presented on alternate days may be considered average, since of the eleven children who learned the material on alternate days, five children learned it in five trials. Among the sixty-two kindergarten children comparable to the Junior Primary Group, one child only learned the material in four trials. Therefore, since two children only of a total of eighty-eight learned the material in four trials, when it was presented on successive days, they must be regarded as exceptional. When the record of the child without a pair, designated "individual, alternate" is included, the average number of trials required for learning the material by the standard form of presentation on alternate days by the twelve children is 5.75. The average number of trials required for learning the material by the standard form of presentation on successive days by the total number of eleven children used in the pairs is 8.73.

Table 6 shows a comparison of the average scores on each trial for learning on succesive days and for learning on alternate days.

TABLE 6
Comparisons of Average Scores by Trials on Each Form of Presentation of Material, Method of Learning, and Learning and Relearning

Form of presentation	Method of learning	Trial													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Score													
Learning on successive days and learning on alternate days: Standard form															
Standard	Successive days	10.2	14.9	16.5	18.8	19.1	19.0	19.8	19.6	19.3	20.0	19.7	20.0	20.0	20.0
Standard	Alternate days	11.3	15.4	18.9	19.6	20.0	19.8	20.0	20.0	20.0					
Learning on Series I and learning on Series II: Variant form															
Single series															
Series I	Successive days	5.7	7.6	9.2	9.5	9.8	9.9	9.9	10.0	10.0	10.0				
Series II	Successive days	5.2	7.6	8.4	9.3	9.7	9.8	10.0	10.0	10.0					
Learning and relearning after an interval of one year: Standard form															
Standard															
Learning	Successive or alternate days	11.0	15.8	18.7	19.8	19.7	20.0	20.0	19.7	20.0	20.0	20.0			
Relearning	Successive or alternate days	17.8	19.5	19.9	20.0	20.0	20.0								

Figure 12 shows this comparison graphically. It is interesting to note that in each group of children, the learning curve reaches the perfect score of 20, but does not remain there for three successive trials. The curve that represents learning on successive days shows more fluctuations than the curve that represents learning on alternate days. The curve representing learning on alternate days has reached and maintained three successive perfect scores of 20 by the ninth trial but the curve representing learning on successive days does not reach 20 until the tenth trial, after

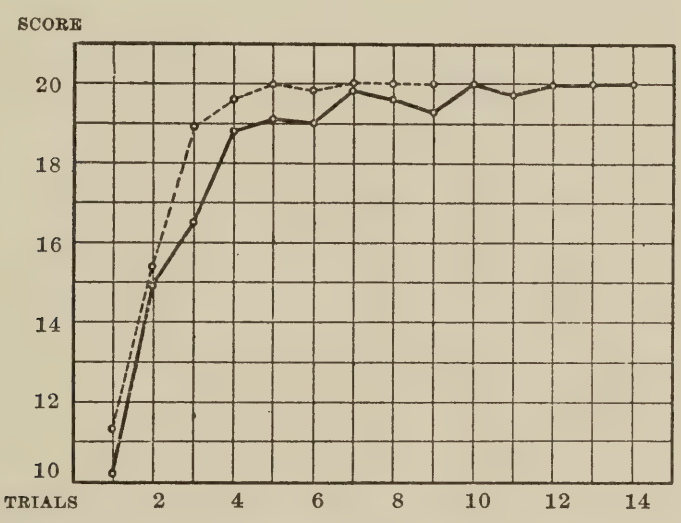

Fig. 12. Average curves of learning on successive days (——) and learning on alternate days (- - - -) when the material was presented according to the standard form.

which there is a decrease before three successive perfect scores are attained on the fourteenth trial.

Although the total number of cases, twenty-two, is small, results on these records indicate that for this type of learning, presentation of material on alternate days results in greater economy of learning than presentation on successive days.

Variant Forms

Standard Form Interchanged: Children Studied Individually.—Fifteen children, seven from the Preschool Laboratory and eight from the Junior Primary Group, were subjects on the phase of the investigation involving the interchange of learned associations. Each of the children had completed the learning according to the standard form of presentation of material, followed by a check on learning. The material was then presented according to the directions for learning, when the learned associations are in-

TABLE 7

Comparison of Number of Trials of Fifteen Children for Learning according to the Standard Form of Presentation of Material and for Learning according to the Standard Form Interchanged

Child	Form of presentation	Trial 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total number of trials	Variation
		Score																					
	Preschool children																						
1	Standard form	10	12	14	18	17	18	18	19	18	18	20	18	20	20	20	*20**					15	— 4
	Standard form, interchanged	5	11	13	15	13	16	19	18	20	20	20	*20*									11	
2	Standard form	5	6	13	14	15	17	18	20	17	20	20	18	18	20	20	20	*20*				16	— 3
	Standard form, interchanged	5	10	13	16	16	16	16	19	16	17	20	20	20	*20*							13	
3	Standard form	3	5	12	15	15	14	18	16	20	20	18	18	18	18	18	18	19	20	20	*20*	20	—11
	Standard form, interchanged	10	14	17	16	20	18	20	20	20												9	
4	Standard form	6	11	15	17	17	19	20	20	20	*20*											9	— 1
	Standard form, interchanged	7	16	18	19	19	20	20	20	*20*												8	
5	Standard form	8	13	19	19	20	20	20	*20*													7	± 0
	Standard form, interchanged	7	13	15	16	20	20	20	*20*													7	
6	Standard form	10	19	20	20	20	*20*															5	± 0
	Standard form, interchanged	11	19	20	20	20	*20*															5	
7	Standard form	3	5	13	15	17	16	16	18	18	19	20	20	20	*19*							13	— 4
	Standard form, interchanged	6	7	12	12	17	15	20	20	20	*20*											9	

	Junior primary children			
1	Standard form	9 19 20 20 20 *20*	5	+ 2
	Standard form, interchanged	13 15 16 18 20 20 20 *20*	7	
2	Standard form	6 16 18 20 20 20 *20*	6	— 1
	Standard form, interchanged	7 18 20 20 20 *20*	5	
3	Standard form	6 18 18 20 20 20 *20*	6	± 0
	Standard form, interchanged	10 14 14 20 20 20 *20*	6	
4	Standard form	13 16 20 20 20 *20*	5	± 0
	Standard form, interchanged	13 19 20 20 20 *20*	5	
5	Standard form	12 18 17 20 20 20 *20*	6	— 1
	Standard form, interchanged	11 19 20 20 20 *20*	5	
6	Standard form	15 16 15 20 20 20 *20*	6	— 1
	Standard form, interchanged	14 18 20 20 20 *20*	5	
7	Standard form	10 16 17 20 20 20 *20*	6	+ 1
	Standard form, interchanged	7 10 14 18 20 20 20 *20*	7	
8	Standard form	15 15 19 20 20 20 *20*	6	— 1
	Standard form, interchanged	11 15 20 20 20 *20*	5	

* Italics denote score on check on learning.

terchanged, as explained in Chapter I. Each child's record on learning when the associations were interchanged was compared with his record on the original learning. Table 7 shows this comparison.

The problem involved in this part of the investigation is to find out whether there is interference or transfer among the various associations that have been formed, when these associations are broken down and others of a somewhat similar nature are built up. Results indicate that there was very little interference. The learning of the material according to the standard form seemed to facilitate the forming of the interchanged associations. Of the fifteen children, nine children learned the interchanged associations in fewer trials than were required for the original learning, four required the same number of trials, one required one more trial, and two required two more trials. Using the total number of trials required for original learning and the total number of trials required for learning the interchanged associations, the coefficient of correlation was computed by Pearson's product-moment method. It was found to be .83 $\pm$ .06, which is sufficiently high to be interpreted that the learning of the associations according to the standard form assists rather than interferes in the learning of the interchanged associations.

The children seemed to enjoy very much the interchange of associations. It amused most of them, particularly on the first trial. This trial was given just after there had been complete learning according to the standard form, when the child was very sure which block belonged with each picture. During the first trial of learning the interchanged associations, when the examiner held up a picture, several of the children glanced toward the block that they had learned to associate with it, and when the examiner picked up a different block, the block that paralleled the one formerly associated with it, the children frequently laughed aloud. It seemed to amuse them to be told that another block "went with" the picture instead of the one that they were accustomed to associate with it. Often, when the examiner said: "Remember, *now*, *this* is the block that goes with *this* picture," the child added, "And *this* is the one that used to go with it." If the child responded this way repeatedly, the examiner usually said, "Yes, but now there is a *different* block that goes with each picture," which is a repetition of a part of the directions that are given just before beginning the first trial of learning

the interchanged associations. Only two children commented upon the direct interchange of the blocks. One child said, "This one [block 1] used to go with the clock and now it goes with the owl, and this is the one [block 11] that used to go with the owl and now it goes with the clock." These two children pointed out the direct interchange of the blocks in a number of instances. The other children knew that different blocks were to be associated with the pictures, but apparently did not observe, or at least did not comment upon, the direct interchange of relationships between blocks and pictures. Of the fifteen children who learned the material according to the interchange of associations, seven made a higher score on the first trial when learning the material according to the interchange of associations than they had made on the first trial of the original learning by the standard form of presentation; six made a lower score; and two made exactly the same score on the first trial when learning the material either by the standard form or according to the variant form, interchange of learned associations.

Single Series: Series I and Series II: Children Studied by Pairs.—Since Series I and Series II of the association reaction material are so comparable, it was decided to give Series I to one child of a pair and Series II to the other child of the pair and compare results.

Since none of the kindergarten children had been given a Stanford-Binet examination before the examiner began to work with them on the learning experiment, and there was not time enough to give each child a Stanford-Binet, the children used in pairs on the single series variant form of presentation, learning on Series I and learning on Series II, were paired on the basis of their records on the Detroit kindergarten test. Since this basis of comparison may be not so accurate as comparison on the basis of similarity in mental age (Stanford-Binet), the children of each pair were selected so that there was not more difference than one month in chronological age between the two nor more than 1 point in score on the Detroit kindergarten test. In some pairs there was no difference in chronological age, in others no difference in Detroit kindergarten score, and in other pairs, no difference in either chronological age or Detroit kindergarten score. With so much similarity of records, the mental ability of the children may be expected to be comparable. In the school system in which these four kindergartens are found, each kindergarten teacher administers the Detroit kindergarten test

TABLE 8

Comparison of Scores of Forty-Eight Kindergarten Children (Paired on the Basis of Scores on the Detroit Kindergarten Test) for Learning of Series I and Series II

Child	Sex	Record on Detroit kindergarten test			Differences		Record on learning experiment										Total number of trials
		Chronological age		Score			Trial										
		Years	Months		Age +	Score +	1	2	3	4	5	6	7	8	9	10	
							Score										
Kindergarten B																	
1	F	4	7	17		1	6	8	8	10	10	10	*10**				6
1a	F	4	8	16	1		6	9	8	10	10	10	*10*				6
2	M	4	10	10		1	8	6	9	10	10	10	*10*				6
2a	F	4	10	9			7	8	9	9	10	10	10	*10*			7
3	M	4	9	12			2	2	4	6	8	8	9	10	10	10	*10*	10
3a	F	4	10	13	1	1	4	10	8	9	10	9	10	10	10	*10*		9
4	F	5	0	26		1	8	10	10	10	*10*							4
4a	M	5	1	25	1		5	10	10	10	*10*							4
5	F	5	3	22	1	1	5	10	10	10	*10*							4
5a	M	5	2	21			9	10	10	10	*10*							4
6	F	5	6	17	1		6	9	10	10	10	*10*						5
6a	M	5	5	17			7	10	10	10	*10*							4
7	M	5	0	15			6	8	8	9	10	10	10	*10*				7
7a	M	5	0	15			4	7	9	10	10	10	*10*					6
8	F	4	11	13			3	7	10	9	10	10	10	*10*				7
8a	M	5	0	13	1		3	8	7	9	9	10	10	10	*10*			8

Kindergarten C																	
1	F	5 — 9	21	1		6	7	8	9	9	10	10	10	*10*			8
1a	M	5 — 8	21			4	5	8	10	10	10	*10*					6
2	M	5 — 5	21		1	8	9	10	10	10	*10*						5
2a	F	5 — 5	20			3	7	10	10	10	*10*						5
3	F	5 — 8	20	1		2	3	9	8	9	10	10	10	*10*			8
3a	F	5 — 7	20			6	10	9	9	10	10	10	*10*				7
4	F	4 — 11	18			5	7	8	10	10	10	*10*					6
4a	M	4 — 11	18			8	9	10	10	10	*10*						5
5	F	5 — 8	15		1	3	5	9	9	10	10	10	*10*				7
5a	M	5 — 9	14	1		1	2	2	7	10	10	10	*10*				7
6	M	5 — 1	13	1	1	4	8	9	9	10	10	10	*10*				7
6a	M	5 — 0	12			1	3	4	5	7	8	10	10	10	*10*		9
7	F	6 — 5	19	1		4	6	9	10	10	10	*10*					6
7a	F	6 — 4	19			5	6	7	10	10	10	*10*					6
Kindergarten D																	
1	F	5 — 7	21	1	1	8	10	10	10	*10*							4
1a	M	5 — 6	20			8	8	8	9	10	10	10	*10*				7
2	M	5 — 6	20		1	10	8	10	10	10	*10*						5
2a	F	5 — 6	19			7	10	10	10	*10*							4
3	F	5 — 0	18		1	4	6	10	10	10	*10*						5
3a	M	5 — 0	17			4	6	8	10	10	10	*10*					6
4	M	5 — 8	17			7	8	9	10	10	10	*10*					6
4a	F	5 — 9	17	1		3	8	10	10	10	*10*						5
5	M	5 — 1	11			5	7	10	10	10	*10*						5
5a	M	5 — 1	12		1	1	1	6	7	8	10	10	10	*10*			8
6	F	4 — 9	16			10	10	10	*10*								3
6a	F	4 — 9	16			4	8	10	10	10	*10*						5

* Italics denote score on check on learning.

TABLE 8 (Continued)
Comparison of Scores of Forty-Eight Kindergarten Children (Paired on the Basis of Scores on the Detroit Kindergarten Test) for Learning of Series I and Series II

Child	Sex	Record on Detroit kindergarten test			Differences		Record on learning experiment										Total number of trials
		Chronological age		Score			Trial										
		Years	Months		Age +	Score +	1	2	3	4	5	6	7	8	9	10	
							Score										
Kindergarten E																	
1	M	5	6	18			6	9	10	10	10						5
1a	M	5	6	18			6	8	10	10	10						5
2	M	5	0	23			5	10	10	10	*10*						4
2a	M	5	1	23	1		10	10	10	*10*							3
3	F	5	6	24			6	10	10	10	*10*						4
3a	M	5	6	24			10	10	10	*10*							3

to the pupils in her own classes. In order to keep constant as far as possible any error due to the personal equation of the examiner because of the fact that the kindergarten teachers are not specially trained in the technic of mental testing, each child was paired with another child who was in the same class and had been given the Detroit kindergarten test by the same teacher. The first child of each pair was given Series I only and the second child of each pair was given Series II only.

Table 8 shows the basis for pairing the forty-eight kindergarten children whose records are used for this section of the study, and the scores obtained by each child on each trial of the learning ex-

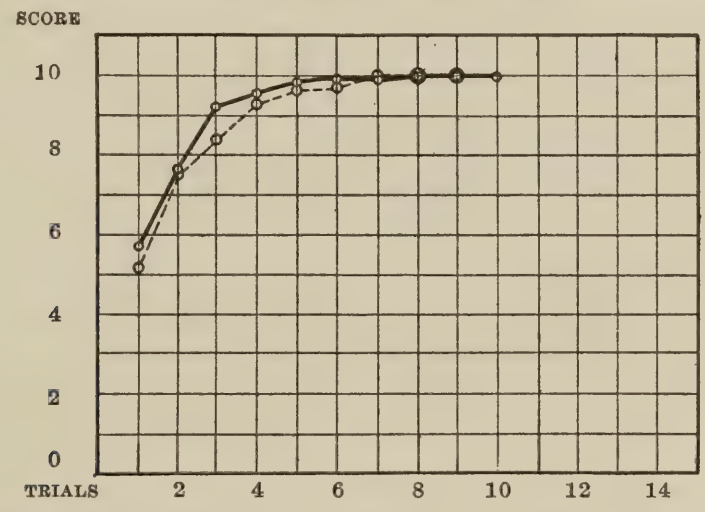

Fig. 13. Average curves of learning on Series I (——) and learning on Series II (- - - -).

periment and the total number of trials required for learning. Results show a marked similarity between the number of trials required by the first child of each pair to learn the ten associations of Series I and the number of trials required by the second child of each pair to learn the ten associations of Series II. The coefficient of correlation between the number of trials required for learning Series I and Series II was .981 ± .054. This was computed by Pearson's product-moment formula. As shown in Table 4, the average number of trials required for learning Series I was 5.61 and for learning Series II, 5.79. It is interesting to note that the average number of trials required for forming ten associations on successive days, found by averaging the average number of trials required for learning Series I and for learning Series II, was 5.75, while the average number of trials for learning the twenty associations according to the standard form of presentation and on alternate days

TABLE 9
Results of Check on Learning after Attainment of Three Successive Perfect Scores

Children	Groupings	Total number of children	Form of presentation																			
			Standard						Variant													
									Standard form interchanged						Single series							
															Series I				Series II			
			Method of learning																			
			Successive days			Alternate days			Successive days			Alternate days			Successive days				Successive days			
			Perfect score	Less than perfect score	No check	Perfect score	Less than perfect score	No check	Perfect score	Less than perfect score	No check	Perfect score	Less than perfect score	No check	Perfect score	Less than perfect score	No check		Perfect score	Less than perfect score	No check	
Preschool	Individual	32	27	2	3				6		1											
Junior primary	Individual	16	13	1	1			1	8													
Junior primary	Paired	22	11			6	1	4	1					2								
Kindergarten A	Individual	35	35																			
Kindergarten B	Individual	15	15																			
Kindergarten B	Paired	16													8				8			
Kindergarten C	Individual	12	12																			
Kindergarten C	Paired	14													7				7			
Kindergarten D	Paired	12													6				6			
Kindergarten E	Paired	6													3				1			2
		180	113	3	4	6	1	5	15		1			2	24				22			2

was also 5.75. Figure 13 shows the average curves of learning Series I and learning Series II. Perhaps the children in the two groups were not exactly comparable but the results seem to have significance when viewed from the standpoint of effect on distribution of practice periods upon learning.

CHECK ON LEARNING

Three successive perfect scores of 20 were followed by the check on learning. Results show that for the material used in this investigation three successive perfect scores is sufficient evidence of complete learning. As shown in Table 9, of the 180 children who completely learned the material, 164 attained a perfect score on one trial of the check and five children only attained less than a perfect score on the check. Eleven of the children who had completed three successive perfect trials had no check on learning because they were absent, the examiner had left for experimental work in another town, or a vacation began just after the child had completed the learning.

In most instances, the children located the pictures very readily during the check on learning. It was only occasionally that a child walked up and down scanning the pictures while trying to find the one with which to respond.

Check on Learning of Standard Form

Of the 132 children who completely learned the material according to the standard form of presentation, 119 made a perfect score on the check on learning, four scored less than 20, and nine children had no check. Of the thirteen children who relearned the material according to the standard form after an interval of one year, every one scored perfect on the check.

Check on Learning of Variant Forms

Of the fifteen children who learned the material according to the variant form, standard form interchanged, that is, interchange of learned associations, each child made a perfect score of 20 on the check.

Of the forty-eight children who learned the material according to the variant form, single series, by which the child learned either Series I or Series II only, one child only failed to make a perfect score of 10 on the check.

RELEARNING AFTER AN INTERVAL OF ONE YEAR

The work with the association reaction material was begun in the spring of one year with a small number of children and continued

TABLE 10
Comparison of Scores by Trials for Learning and Relearning after an Interval of One Year

Child	Form of learning	Trial																Total number of trials	Decrease in number of trials necessary for re-learning
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
		Score																	
Learning on alternate days																			
1	Learning	10	17	20	20	20	*20**											5	1
	Relearning	16	20	20	20	*20*												4	
2	Learning	18	19	20	20	20	*20*											5	1
	Relearning	19	20	20	20	*20*												4	
3	Learning	6	14	20	20	20	*17*											5	0
	Relearning	18	18	20	20	20	*20*											5	
4	Learning	8	16	20	20	20												5	1
	Relearning	15	20	20	20	*20*												4	
5	Learning	8	15	19	20	20	20	*20*										6	1
	Relearning	14	18	20	20	20	*20*											5	
6	Learning	17	17	18	20	20	20											6	2
	Relearning	19	20	20	20	*20*												4	
7	Learning	13	15	17	20	20	20											6	2
	Relearning	19	20	20	20	*20*												4	

		Learning on successive days																		
8	Learning	13	17	20	20	19	20	20	19	20	20	20	*20*						11	8
	Relearning	20	20	20	*20*														3	
9	Learning	6	11	14	19	19	20	20	20	*20*									8	4
	Relearning	18	20	20	20	*20*													4	
10	Learning	7	16	19	20	20	20	*20*											6	2
	Relearning	18	20	20	20	*20*													4	
11	Learning	17	20	20	20	*20*													4	1
	Relearning	20	20	20	*20*														3	
12	Learning	9	12	17	18	19	20	20	20	*20*									8	2
	Relearning	17	18	19	20	20	20	*20*											6	
13	Learning	10	12	14	18	17	18	18	19	18	18	20	18	20	20	20	*20*		15	12
	Relearning	20	20	20	*20*														3	

* Italics denote score on check on learning.

through the whole of the following school year. It was planned to repeat the experiment one year later with the children who were still available. Thirteen children who had learned the material by the standard form of presentation exactly one year previously were given it again in order to compare their scores and rate of learning on the original learning with their scores and rate of learning after an interval of one year. Of the thirteen children, seven had learned the material originally on alternate days and six had learned it originally on successive days. For this study of relearning, the material was presented to the child by the method of learning that had been used originally. In several instances, the child had been paired the previous year with a child who was no longer in the school and therefore not available as a subject for relearning of the material. This, however, did not prevent the child of the pair who was still in the school from being a subject for relearning since for the study of relearning each child's record is compared with his own record of learning one year earlier, regardless of whether or not he was one of the children studied as one of a pair or individually.

Table 10 shows a comparison of individual records by trials for learning and for relearning after an interval of one year. Subjects 1 to 12 were in the Junior Primary Group at the time of the original learning and in the first grade at the time of relearning; subject 13 was in the Preschool Laboratory at the time of original learning and in the Junior Primary Group at the time of relearning.

With the exception of Child 3, who required five trials for learning the material on alternate days and five trials for relearning the material by the same method, each child showed a decrease in the number of trials required for relearning as compared with the number of trials required for learning. No child showed an increase in the number of trials required for relearning the material. In Table 7, the column giving the decrease in number of trials for relearning shows another interesting point. The range of difference in number of trials on relearning as compared with learning for the thirteen children is from 0 to 12. When the two groups of children are considered separately, those who learned and relearned the material on successive days and those who learned and relearned the material on alternate days, a still more interesting fact stands out. Of the seven children who relearned the material on alternate days, one required the same number of trials for relearning as for learning, four showed a decrease of one trial, and two a decrease of two trials. Of the six

children who relearned the material on successive days, one showed a decrease of one trial in the number of trials required for relearning, two showed a decrease of two trials, one showed a decrease of four trials, one a decrease of eight trials, and one a decrease of twelve trials. The average of the decrease in number of trials for relearning of those who learned and relearned the material on alternate days is 1.14 trials and for those who learned and relearned the material on successive days is 4.83 trials. The children who learned the material on alternate days had required fewer trials than those who learned it on successive days, and showed a smaller decrease in the number of trials for relearning. The explanation of this may be that the children who learned the material on alternate days

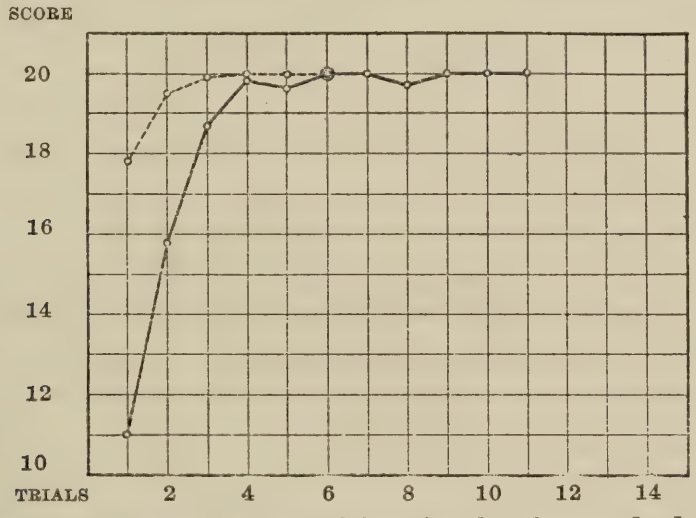

Fig. 14. Average curves of learning by the standard form of presentation (——) and relearning after an interval of one year (- - - -).

made such rapid progress that they soon reached their physiological limit beyond which there is little room for improvement. The decrease in number of trials required for relearning is therefore very small, since the original learning was accomplished at approximately maximum speed of forming the required associations. The children who learned the material on successive days made slower progress on the original learning and required so many trials for learning that there was still much room for improvement. The decrease in number of trials required for relearning was therefore greater.

Table 6 shows a comparison of the average scores by trials for learning and relearning after an interval of one year. By the sixth trial, the relearning curve has reached a score of 20 and maintained

it for three successive trials. The learning curve has reached 20 for the first time on the sixth trial and after maintaining this score for two trials, falls back before attaining three successive scores of 20. Figure 14 presents the average curve for scores by trials for learning and relearning after an interval of one year, and Figure 15, four individual curves. All but one of the children accomplished relearning after an interval of one year in fewer trials than were required for the original learning; in the one exceptional case, learning and relearning were accomplished in the same number of trials.

As soon as the child finishes the first trial of relearning, the examiner asks him three questions. First, "Did you ever play this game before?" If the child responds "Yes," the second question

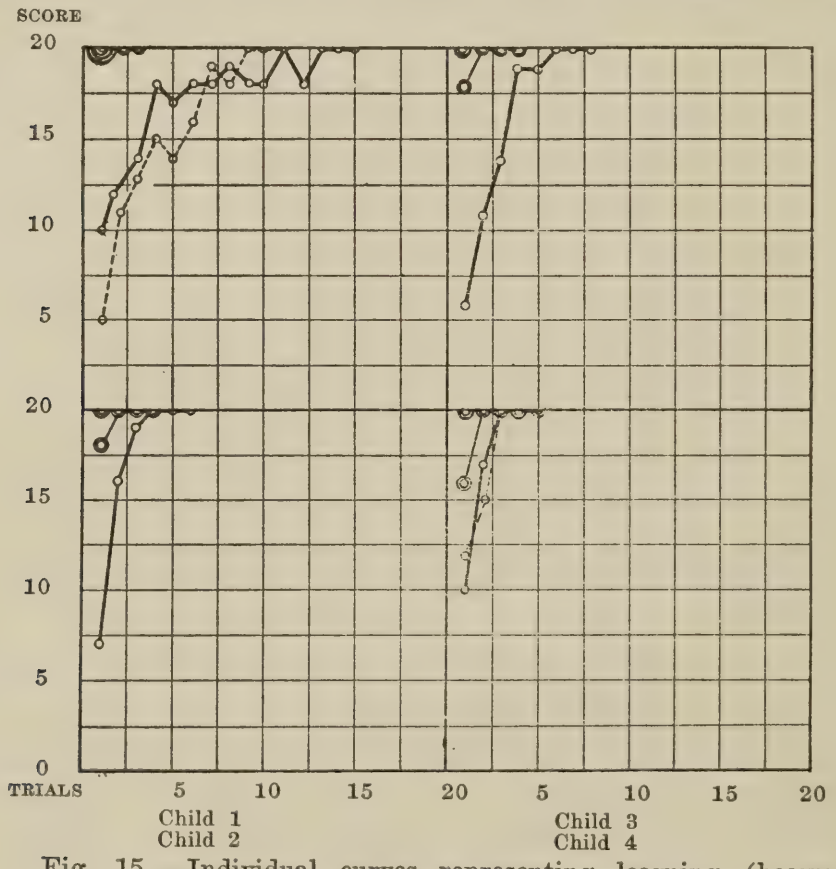

Fig. 15. Individual curves representing learning (heavy ——) and relearning after an interval of one year (light ——) on the standard form of presentation. Child 1 and Child 4 also learned the material according to the standard form interchanged (- - - -). Child 1, it will be noted, scored 20 on three successive trials on relearning.

is asked, "When did you play the game before?" After the child has responded, the examiner asks the third question, "Did you remember how to play the game?" One child of this group only

said "No" to the first question and one child said, "I don't know. I don't remember." All of the eleven remaining children said that they remembered "the game." In some cases it was unnecessary to ask the question since several of the children said near the beginning of the experiment that they remembered the game, or that they had played this game before, or that they had played it when they were in the Junior Primary Group the year before. The youngest child to whom the relearning was given (Child 13, Table 7), the only one who was in the Preschool Laboratory at the time of learning the material and in the Junior Primary Group at the time of relearning, showed clearly that he remembered not only "the game," but also many of the factors of the situation while learning it. When Robert was asked if he had ever played "the game" before, he responded at once, "Oh yes," and when asked, "When did you play the game before?" he explained in detail by saying, "Oh, a long time ago when I was over at the Preschool. When I was in that *little* room over at the Preschool we played it. We played it on this *same* table too." The place localization was remarkably accurate. The year previous, the examiner had carried on this learning experiment in the smallest examining room at the Preschool Laboratory. The table used was a special type of table from the art department. Although Robert was incorrect in saying it was "the *same* table, too" that was being used during the relearning, it was a drawing table exactly like the one used during the time of the original learning. When asked, "Did you remember how to play the game?" Robert responded, "Let's see if I can think of any. I remembered they were placed like this. I remembered the clock and I remembered this [picking up block 13] and this [block 2] and this [block 7] and this [block 14], but some I didn't know." This child had taken fifteen trials in which to learn the material, but scored 20 on the first trial on relearning and for the two following trials also. The check on relearning was scored 20 also, so that each time he was given the material one year after the original learning he made a perfect score.

LEARNING CURVES

One of the factors in the learning process that has been the subject of much discussion is the plateau. Several investigators have tried to solve certain problems in regard to it, but no agreement has been reached in answer to questions such as, What is the nature of the plateau? What is the cause of the plateau and how is it to be

TABLE 11
Number and Distribution of Plateaus in Learning Curves of 180 Children

Children	Groupings	Form of presentation	Method of learning	Total number of children	Number of plateaus					
					0	1	2	3	4	5
Preschool	Individual	Standard	Successive days	32	9	10	7	4	1	1
Junior primary	Individual	Standard	Successive days	15	11	4				
Junior primary	Individual	Standard	Alternate days	1	1					
Junior primary	Paired	Standard	Successive days	11	6	3	2			
Junior primary	Paired	Standard	Alternate days	11	9	2				
Kindergarten A	Individual	Standard	Successive days	35	22	13				
Kindergarten B	Individual	Standard	Successive days	15	9	6				
Kindergarten B	Paired	Single series	Successive days	16	11	4	1			
Kindergarten C	Individual	Standard	Successive days	12	8	4				
Kindergarten C	Paired	Single series	Successive days	14	9	5				
Kindergarten D	Paired	Single series	Successive days	12	10	2				
Kindergarten E	Paired	Single series	Successive days	6	6					
				180	111	53	10	4	1	1

interpreted? Is the plateau an essential of all types of learning or is it peculiar to certain types only?

The individual learning curves plotted for the children in the investigation brought out some interesting, and it may be significant, facts in regard to plateaus as found in this type of association reaction learning of young subjects. Of the 180 children (Table 11), 111 (61.6 per cent) have no plateaus in their learning curves and sixty-nine have from one to five plateaus. Of the 120 children who learned the material according to the standard form of presentation on successive days, the largest number of children who can be grouped together on the basis of a common factor, seventy-five (62.5 per cent) have no plateaus and forty-five have from one to five plateaus. It is an interesting fact that the difference in percentage between children having no plateaus on all forms of presentation considered collectively, and for the standard form of presentation, the form by which the largest number of children learned the material, is only 0.9. Another interesting point is the fact that the greater number of plateaus occurs among the curves of the younger children. Of the 150 children of the junior primary and kindergarten groups, 104 (69.3 per cent) have no plateaus, forty-three (28.6 per cent) have one plateau, and three (2.0 per cent) have two plateaus. Among the preschool children, however, the situation is very different; of the thirty-two, nine (28.1 per cent) have no plateaus, and twenty-three (71.9 per cent) have from one to five plateaus. A smaller number of preschool children have no plateaus than have one plateau, and this situation is not found in any other group of children in this study. From these facts it may be concluded that plateaus are not a necessity in this form of association reaction type of learning and that whether or not they occur seems to be a matter of individual differences and of maturity.

An interpretation of the plateau that seems applicable to the learning curves under discussion is that sometimes when new associative bonds are formed, particularly if several new bonds are formed at almost the same time, they are not formed with sufficient security to be fixed and a basis for the upbuilding of further associations. The fact that a plateau or even a decrease in score almost always follows a very large increase seems to suggest a relation between the period of rapid progress and the period when apparently no progress is taking place. Progress, in one sense, probably is occurring, that is, new associative bonds that were formed at the time

of the very rapid progress are becoming fixed and automatized. Until automatization of these bonds has taken place, there can be no further progress. Figures 16 and 17 show the plotted records of eight children who with one exception had a trial on the learning material according to the standard form of presentation and on successive days; Child 2, Figure 16, was given the material on alternate

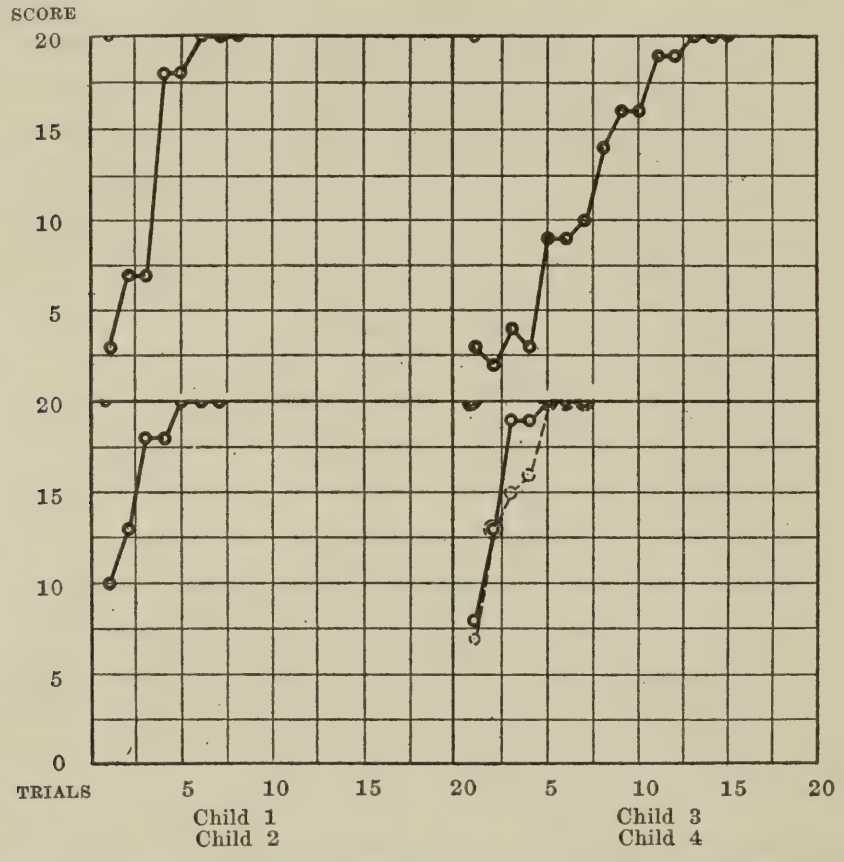

Fig. 16. Individual learning curves of four children who learned the material according to the standard form of presentation (——). Child 4 also learned the material according to the standard form interchanged (- - - -). The method of learning by Child 1, Child 2, and Child 3 was by trials on successive days; by Child 4, on alternate days.

These four curves show plateaus following on large increases in the number of associations formed.

days. The learning curves of the children designated Child 1, 2, 3, and 4, Figure 16, and Child 1 and Child 3, Figure 17, represent a large increase in number of associations formed, followed by a plateau, and the curves of Child 2 and Child 4, Figure 17, show a decrease in score following upon a large increase. These are a few random samplings, but in almost every learning curve in which one or more plateaus occur, a large gain is to be found immediately before each plateau.

Recently, there has come into usage in psychological literature the term "shock absorber" to denote a preliminary test that is given to subjects who are not accustomed to psychological test conditions in order to familiarize them with the type of test on which they are to be scored. The difference in response on the first trial between children accustomed to psychological tests and those unaccustomed

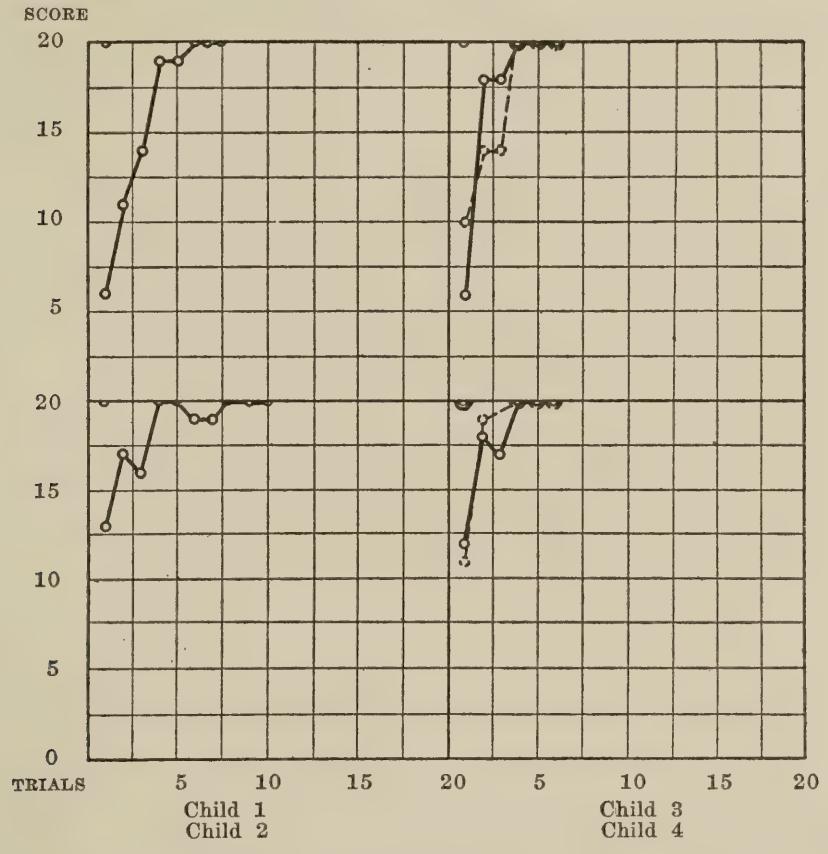

Fig. 17. Individual learning curves of four children who learned the material according to the standard form of presentation (——) by trials on successive days. Child 3 and Child 4 also learned the material according to the standard form interchanged (- - - -).

The learning curves of Child 1 and Child 3 show plateaus following on large increases in the number of associations formed, and the learning curves of Child 2 and Child 4 show a decrease in score following a large increase.

to them is well demonstrated in the results obtained on the junior primary and kindergarten groups, in which the children are comparable in age and school status.

In the Iowa Child Welfare Research Station Laboratories, special psychological problems are being investigated constantly so that every preschool and junior primary child had had several psychological tests previous to being a subject for the learning experiment, and many of the children who had been in the preschool group the

year or years previously had taken a large number of psychological tests and were thoroughly habituated to psychological test conditions or to "play a game," as the examiners always suggest when a child is asked to leave the play group to go into the examining room for a mental test.

The kindergarten children were not accustomed to taking psychological tests. With a few exceptions they had been given the De-

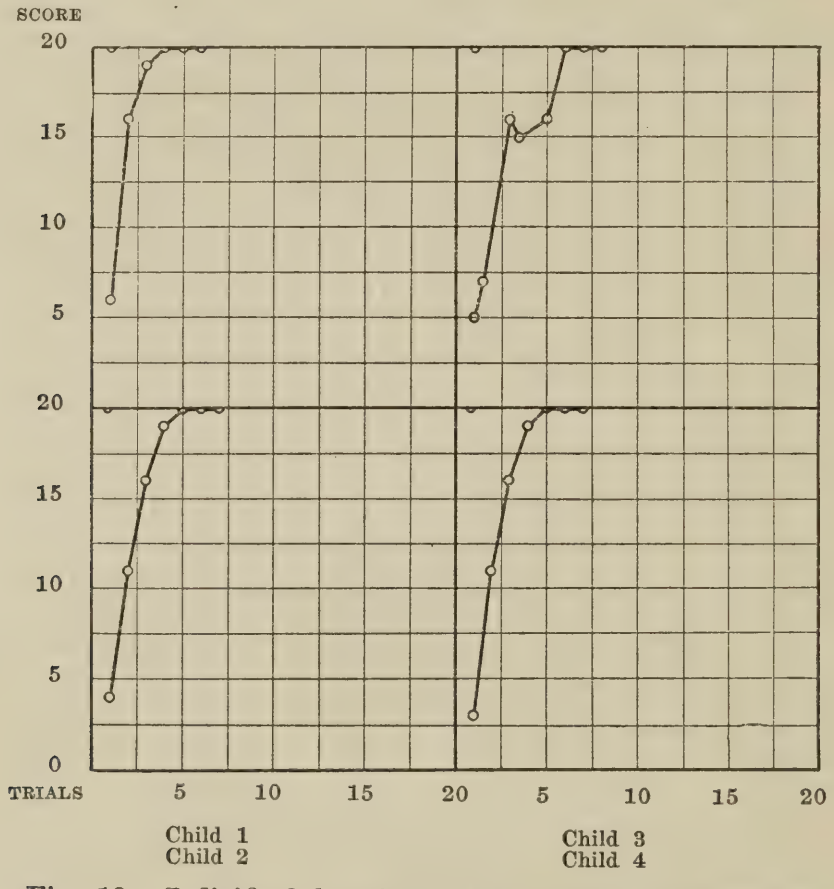

Fig. 18. Individual learning curves of four kindergarten children who learned the material according to the standard form of presentation by trials on successive days.

These curves show the tendency to begin with a low score followed by a rapid rise.

troit kindergarten test seven months previously by their teachers, but some had never had a psychological test of any kind.

The majority of junior primary children began with a score of 9 or more and several of them began with a score of 15 or more. The majority of the kindergarten children, however, began with a very low score. Several of the very bright kindergarten children scored 3 or 4 points on the first trial and a number scored 5 or 6 points. Those who began so low invariably showed a very rapid rise, after

which their learning curves progressed very much the same as the learning curves of the junior primary children (Figures 18 and 19). In no case did a junior primary child make so large an initial gain as was made by many of the kindergarten children.

The children were not afraid of the examiner, their coöperation was excellent, and they seemed interested in the blocks and pictures. As far as could be observed, there were no extraneous factors that

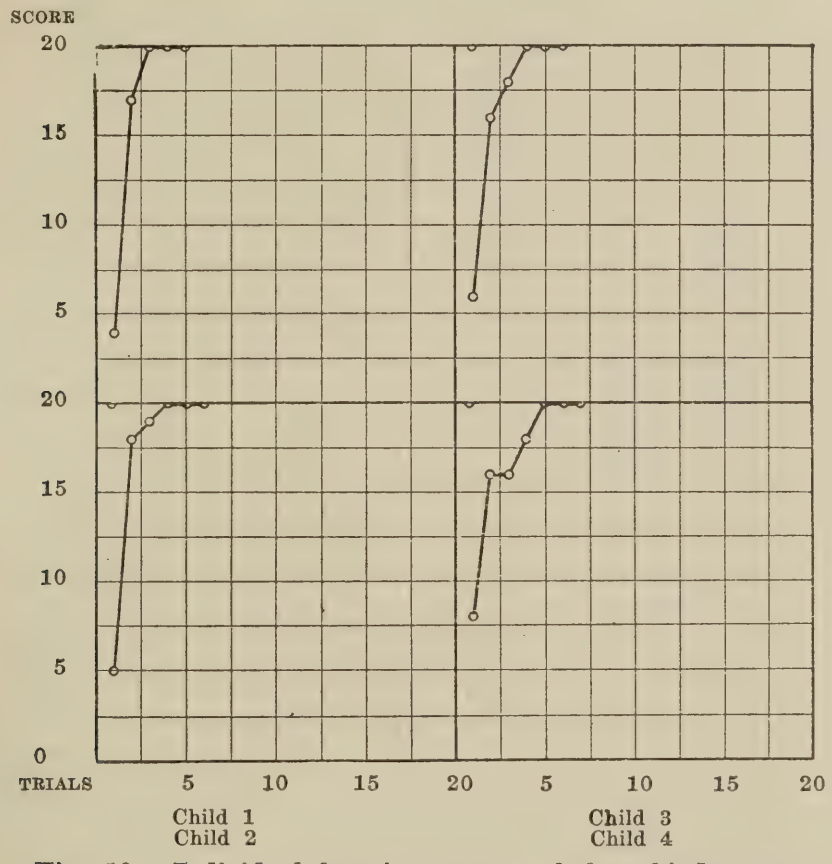

Fig. 19. Individual learning curves of four kindergarten children who learned the material according to the standard form of presentation by trials on successive days.

These curves, like those in Figure 18, show the tendency to begin with a low score followed by a rapid initial rise.

might detract from the children's attention, or in any way account for the low score on the first trial made by all of the kindergarten children, unless it was necessary for the children to become accustomed to psychological test conditions. Since the kindergarten children complete the learning within the same number of trials as the junior primary children with whom they are comparable and the number of the trial on which the child attains the third consecutive perfect score is the measure of learning for this experiment, the factor of a low score on the first trial is hidden in the results.

SCORES

A tabulated record was kept of the score made by each child on each trial. For certain comparisons, such as a comparison of the

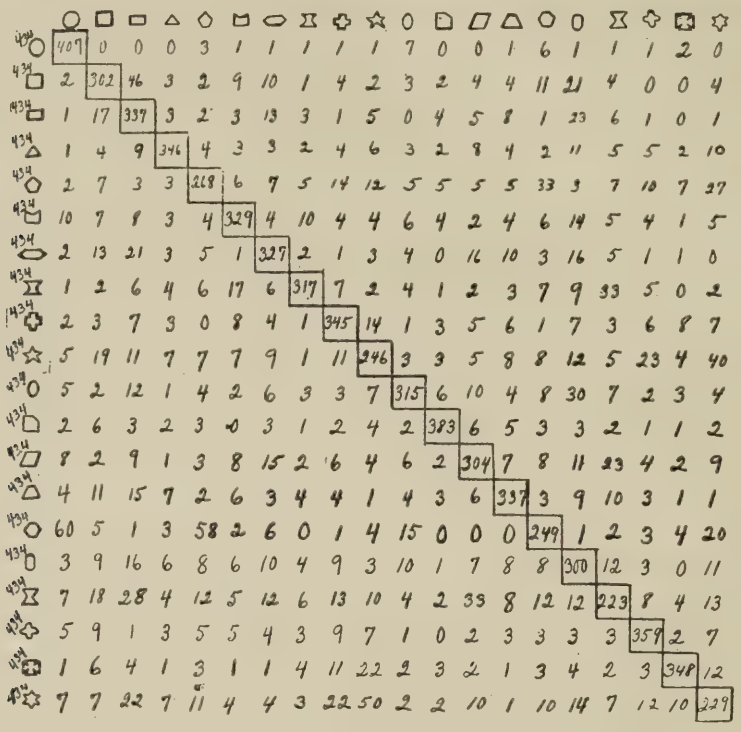

Fig. 20. Summary of the distribution chart of the analysis of successes and errors on the 434 trials of the thirty-two preschool children who learned the material according to the standard form of presentation on successive days. Beginning at the top left corner, the order of the drawings of the blocks on both the perpendicular and horizontal represents the order in which the child is to respond.

The method of reading the chart is as follows: Select any block in the perpendicular column; read across to the column below any other block; the number at the point of intersection is the number of times the block on the horizontal was given for the block on the perpendicular.

The figures on the diagonal show the number of times each block was given correctly.

records of several children or of the records of children whose scores are almost the same for several trials, the tabulated records of individual scores on each trial present the data more effectively than the individual learning curves. Among the tables that show tabulated individual scores are Tables 5, 7, 8, and 10.

ANALYSIS OF ERRORS

In order to analyze the data obtained from this experiment, it is necessary to know not only how many errors are made, but exactly what these errors are. A child's correct response is indicated on

the score sheet by a plus sign upon the corresponding figure. When a child responds with the incorrect block, instead of simply indicating an error by a minus sign, the examiner draws the incorrect block upon the score sheet beside the outline of the block. By means of distribution charts, successes and errors have been tabulated and charted for the various groups of children according to each form of presentation and each method of learning. In this way, it may be seen how many times each one of the blocks has been given correctly and how many times each one of the blocks has been confused with each of the other nineteen blocks.

Figure 20 shows the frequency of correct responses and of errors of the thirty-two preschool children who learned the material according to the standard form of presentation on successive days, with a total of 434 trials. A study of this chart reveals certain interesting facts: The six-pointed star, block 20, was given forty times instead of the five-pointed star, block 10, and the five-pointed star, block 10, was given fifty times instead of the six-pointed star, block 20. The regular hexagon, block 15, was given thirty-three times instead of the regular pentagon, block 5, and the regular pentagon, block 5, was given fifty-eight times instead of the regular hexagon, block 15. In these instances, the large number of errors was due to confusion between two similar blocks. In other instances, the errors were due to confusion between two pictures of somewhat similar objects. For example, block 17 was given twenty-three times instead of block 13, and block 13 was given thirty-three times instead of block 17. Block 13 is to be associated with the picture of a flying bird and block 17 with the picture of a duck. Sometimes, the confusion was not between block and block, or picture and picture, but between block and picture. This is illustrated best by the confusion of the round block, block 1, and the picture of a six-spoked wheel, picture 15. The round block, block 1, was given sixty times incorrectly in response to the picture of a six-spoked wheel, picture 15. On the other hand, block 15 was given six times only for picture 1. This shows definitely that the errors were due neither to a confusion of one block with another, nor to a confusion of one picture with another, but to the confusion of a block with a picture.

Figure 21 presents the records of the correct responses and errors of sixty-two kindergarten children who had a total number of 435 trials. A comparison of Figures 20 and 21 brings out an interesting

fact. The number of kindergarten children is almost exactly twice the number of preschool children, yet the total number of trials required by the sixty-two kindergarten children is 435 and the total number of trials required by the thirty-two preschool children is 434. This is a striking example of decrease in number of trials required for learning with increase in age.

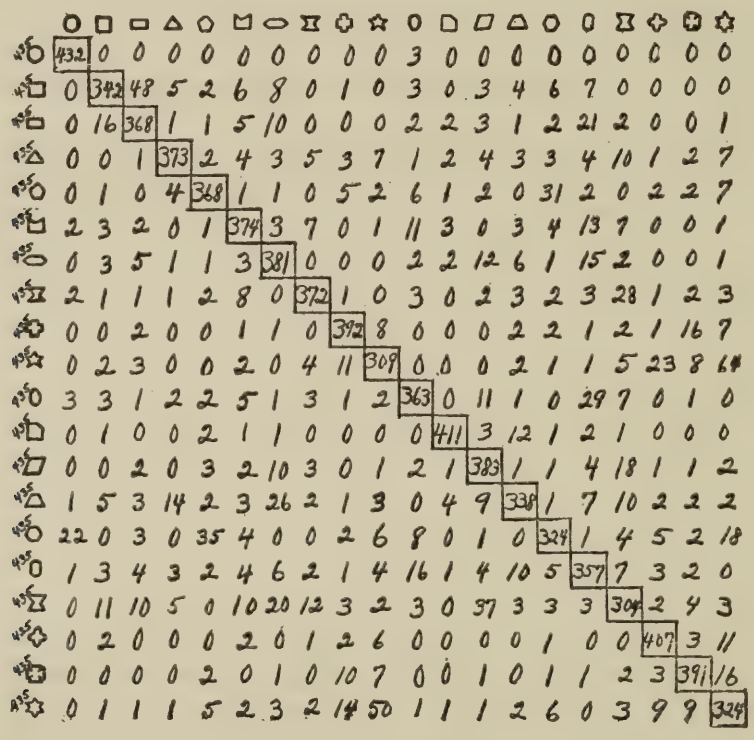

Fig. 21. Summary of the distribution chart of the analysis of successes and errors on the 435 trials of the sixty-two kindergarten children who learned the material according to the standard form of presentation on successive days.

This chart is read by the same method as the chart shown in Figure 20.

A comparison of the confusion shown in Figures 20 and 21 shows a remarkable similarity of errors made by preschool and kindergarten children. For example, by the kindergarten children (Figure 21) the six-pointed star, block 20, was given sixty-four times instead of the five-pointed star, block 10, and the five-pointed star, block 10, was given fifty times instead of the six-pointed star, block 20. The regular hexagon, block 15, was given thirty-one times instead of the regular pentagon, block 5, and the regular pentagon, block 5, was given thirty-five times instead of the regular hexagon, block 15. Block 17 was given eighteen times instead of block 13, and block 13 was given thirty-seven times instead of block 17. Block 1 was given

twenty-two times when picture 15 was shown, but block 15 was not given once for picture 1.

Figure 22 shows the successes and errors of the twenty-two junior primary children. Eleven of these children learned the material according to the standard form of presentation on successive days, with a total of ninety-five trials, and eleven on alternate days, with

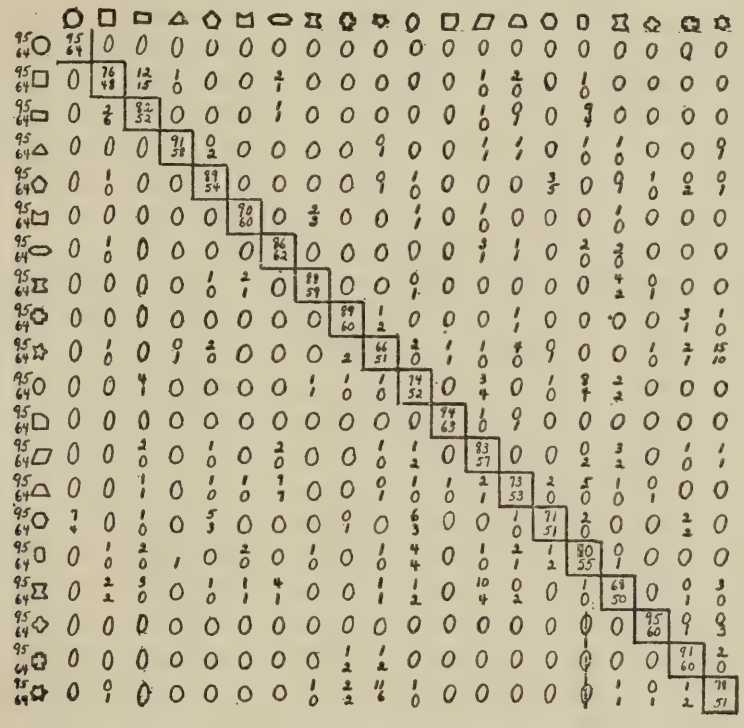

Fig. 22. Summary of the distribution chart of the analysis of successes and errors of the twenty-two junior primary children who learned the material according to the standard form of presentation, on successive days for eleven children, who required ninety-five trials, and on alternate days for eleven children, who required sixty-four trials.

This chart is read by the same method as the chart shown in Figure 20. The upper number of each pair of numbers at the intersection represents the records of the children who learned the material on successive days.

a total of sixty-four trials. Since these children were so comparable on three variables, mental age, height, and weight, the reduction of thirty-one in the number of trials required for learning the material according to the standard form on successive days when compared with the number of trials required for learning the material according to the standard form on alternate days is probably the most significant fact shown by this chart.

A chart was made representing a summary of the distribution

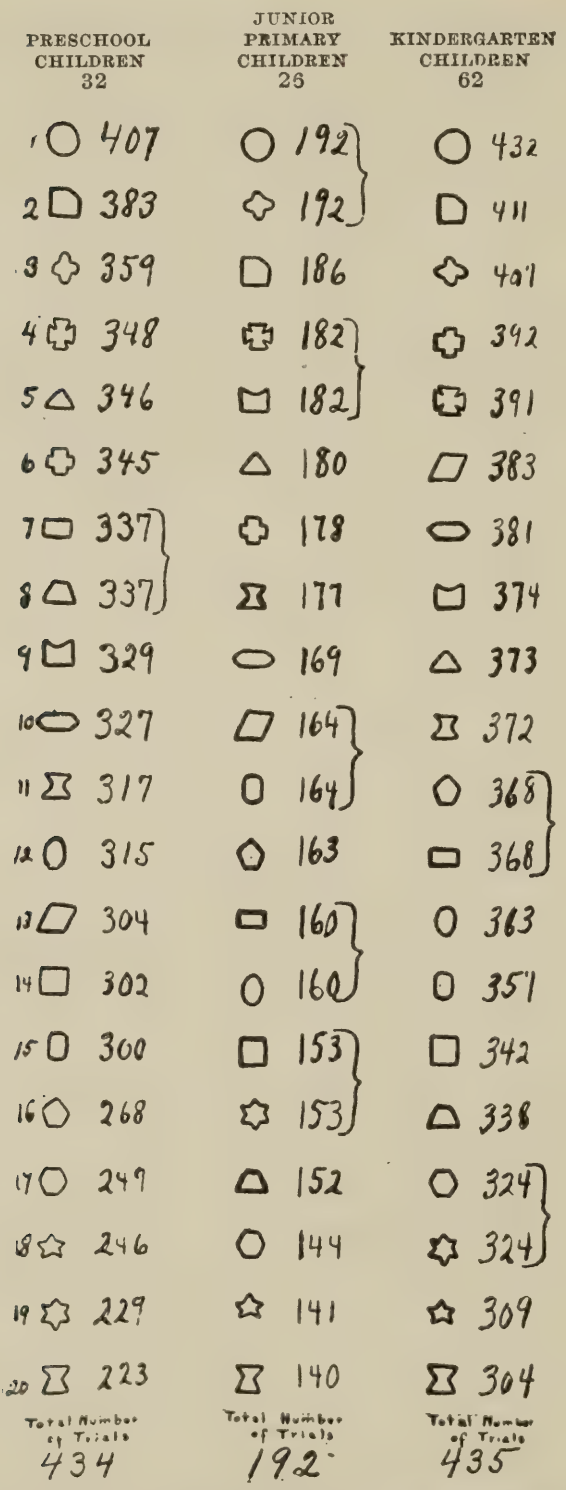

Fig. 23. Order of difficulty, from least difficult to most difficult, in forming the required associations of twenty blocks and twenty pictures, found from an analysis of the records of thirty-two preschool children, twenty-six junior primary children, and sixty-two kindergarten children, each of whom learned the material according to the standard form of presentation on successive days.

chart of the analysis of successes and errors of the twelve junior primary children, five of whom learned the material according to the standard form of presentation on successive days, and seven on alternate days, with the frequency of correct responses and of errors for each group together with the number of successes and failures for each group when relearning the material one year later according to the standard form of presentation on successive or alternate days, according to the method that was used in the learning of the material one year earlier. Charts showing the summary of the analysis of successes and errors on each of the two variant forms of presentation of material were made also. These three charts are not included because of their general similarity to Figures 20, 21, and 22.

ORDER OF DIFFICULTY IN FORMING THE REQUIRED ASSOCIATIONS

The figures on the diagonal through each of the charts representing a summary of correct and incorrect responses show the number of times each block was given correctly, since it is at these points that the drawing of each block on the perpendicular intersects with the drawing of the same block on the horizontal. In order to ascertain the order of difficulty in forming the required associations, the figures on each chart that are found on the diagonal were arranged in order from highest to lowest. This represents the order of difficulty from least difficult to most difficult in forming the required associations. Figure 23 represents the order of difficulty from least difficult to most difficult in forming the required associations of twenty blocks and twenty pictures as found from the records of thirty-two preschool children, twenty-six junior primary children, and sixty-two kindergarten children each of whom learned the material according to the standard form of presentation on successive days. There is a very close similarity between the order of difficulty for the children in the three groups. As would be supposed, greater similarity was shown in the order of difficulty between the junior primary and the kindergarten children than between the preschool and the junior primary children or between the preschool and kindergarten children. In order to study the apparent similarity, coefficients of correlation were computed by Pearson's rank difference method for each combination of two of the groups of children:

	r	P.E.
Preschool and junior primary	.84	±.04
Preschool and kindergarten	.86	±.04
Junior primary and kindergarten	.95	±.17

The coefficient of correlation in each case is a sufficient number of times larger than the probable error to be significant.

COMMENTS OF THE CHILDREN DURING THE EXPERIMENT

The pictures used in this experiment were designed purposely to resemble in some way the blocks with which they are to be associated, but an attempt was made to have the pictures not too similar to the blocks, in order to avoid the possibility of the situation's resolving itself into merely a matching of block and picture. Even the youngest child, aged two years and two months, observed and commented upon certain of the resemblances. The material elicited a great deal of comment from almost every child to whom it was presented. In addition to remarks that stated the resemblance of certain parts of the picture to certain parts of the block or to the block as a whole, or of the block as a whole to the picture as a whole, or to certain parts of the picture, many of the children gave to certain blocks the name of the object represented in the picture with which the block corresponds. Many of the children when looking for a block asked, "Where is the train?" "Where is the drum?" "Where is the flower?" or, after having found the required block, exclaimed, "Here's the train," "I found the drum," or "This is the flower," in each case identifying the block by the name of the object represented in the picture that corresponds to the block. The blocks seemed to be the actual objects to the children. This may be due in part to the fact that few of the children knew the names of the various shaped blocks. Some of the children referred to the round block as "the round one"; some referred to the five or six-pointed star as "stars"; only a very few of the children referred to the square block as "a square"; and none of the other blocks was referred to by name except when the block was called by the name of the picture to which the block corresponds. A large majority of the children tried to fit the blocks upon the pictures. Some of them responded in this way from the first trial; others, following the directions a little more closely, responded at first by handing each block to the examiner, but later, as resemblances stood out more clearly in their minds probably, began to fit certain blocks, or each block, upon corresponding pictures. Some of the children, when trying to fit a block on a picture to which there is an obvious resemblance seemed annoyed or disappointed when it was too large or too small to fit the picture exactly. Many of the children commented upon this, particularly in regard to block 8 and picture 8, saying,

"This block is too fat" or "Why doesn't that go farther in?" referring to the concave sides of block 8. The fact that there was no stem attached to block 18, which corresponds with the picture of a flower on a stem, picture 18, annoyed some children who commented, "It [the block] is just like it [the picture], but it hasn't got this" [pointing to the stem on the picture of the flower]. More often the children asked a question in regard to the dissimilarity between picture and block than made a statement in regard to the dissimilarity. Generally it was in the form, "Why doesn't this [the block] have this [referring to some part of the picture that is not a part of the block] on it?" For example, the regular pentagon, block 5, seemed incomplete to many of the children because it has nothing attached to it that resembles the tail of the kite in the picture that is to be associated with it, although in other respects the block and picture are identical in shape. This occurred in several other associations besides in connection with those mentioned. It seemed that the children after having found a similarity between block and picture looked for identity between the two.

One outstanding fact of the learning situation as a whole was the general optimism of the subjects as expressed in their comments. It was a usual occurrence for a child to say, "I got them *all* right today," as soon as one of the trials had been finished. Often, this was after one of the trials near the beginning of the child's learning of the material when his score was far from perfect. Sometimes the child would not seem so positive of his absolute correctness and after stating, "I got them *all* right today," added, "Didn't I?" and looked questioningly at the examiner. Sometimes before beginning a trial a child said, "I got them all right the last time and I'm going to get them all right today," although on neither the earlier performance nor on the later one had a perfect score been made. One preschool boy remarked, "I know them, don't I?" at the end of the first trial. His score was 8.

One time as the examiner was taking a child back to the kindergarten room, she met another kindergarten child, Mildred, just outside the door of the examining room. The examiner had not intended having Mildred next but when she remarked, "I came next because I wanted to play the game. Can I play next?" the examiner let her have her turn then. This was Mildred's third trial and she made a score of 18. When she had finished this trial, she remarked, "Maybe I'll get them *all* right tomorrow." Then an in-

stant later she added, "Maybe I won't. We can't tell yet. Who do you want next? I'll go and get them." Mildred showed more self-criticism than most of the children and realized that she had not made a perfect score. The next day, as Mildred entered the examining room, she remarked, "I think I'll get them *all* right today."

Many of the children remarked upon the ease in associating the correct block with a certain picture; fewer of the children remarked upon the difficulty. Comments such as "That's an easy, easy one" usually referred to block 1 and picture 1, the picture of the face of a clock, and to block 18 and picture 18, the picture of a flower. Although many of the children were unable to recognize the picture of the old fashioned desk, picture 12, the block that is associated with it, block 12, is so similar that the response for this association also, brought out the comment, "That's easy."

A great many of the children said that they liked the game or made a remark such as, "This is a nice game." There was only one child among the 205 with whom the experiment was tried who seemed to tire of the game. This was a boy who was the dullest child enrolled in the Preschool Laboratories. After about fifteen trials he seemed somewhat reluctant to come to "play the game." With this one exception, all of the children were interested in "the game" and the materials used appealed to them and held their attention. They did not tire of the repetition. Perhaps the same thing in a child's make-up that causes him to want to be told the same story again and again, or to be shown the same pictures over and over, or to have the same songs sung repeatedly, makes the child like to "play the block game" for many trials without tiring.

More of the individual comments of the children will be given in Chapter IV, where a special study is made of twelve interesting subjects of the experiment.

Statistical Analysis

It has been stated that the number of children at each age and on each form of presentation of the material is too small to yield reliable statistical results except for the five and one-half-year age group of children who learned the material according to the standard form of presentation on successive days. Almost all of the statistical results given here are based therefore upon this one age group and according to this one form of presentation and one method of learning. The correlations have been worked separately for junior primary and kindergarten children.

RELIABILITY OF THE EXPERIMENT

The reliability of the experiment was found by correlating the scores on one half of the material (Series I) with the scores on the other half of the material (Series II) on all records of children five and one-half years of age who had learned the material according to the standard form of presentation on succcessive days. The reliability coefficient of one half of the material correlated with the other half is .83 ± .02 for the junior primary children and .83 ± .01 for the kindergarten children. The reliability of the experiment was found in another manner, by correlating the scores on the odd and even items of the material on all records of children five and one-half years of age who had learned the material according to the standard form of presentation on successive days, it is .87 ± .01 for the junior primary children and .85 ± .01 for the kindergarten children.

When the Spearman-Brown prophecy formula[2] was applied for the two halves of the material, the result was .91 for both the junior primary and kindergarten children. When the Spearman-Brown prophecy formula was applied for the odd and even items of the material, the result was .93 for the junior primary children and .92 for the kindergarten children.

The correlation between Series I and Series II is based upon the records of the children who learned all of the material of both series together as one series. A correlation of the scores on Series I and Series II of paired kindergarten children, one of each pair having learned Series I only and the other of the pair having learned Series II only, gives a reliability coefficient of .98 ± .05. A summary of these statistical results is as follows:

Children	r P.E. Same child	r P.E. Paired children	Spearman-Brown Prophecy Formula
	Scores on Series I and Series II		
Junior primary	.83 ±.02		.91
Kindergarten	.83 ±.01	.98 ±.05	.91
	Scores on Odd and Even Items		
Junior primary	.87 ±.01		.93
Kindergarten	.85 ±.01		.92

2. $r_x = \frac{Nr_1}{1+(N-1)r_1}$

CORRELATIONS BETWEEN THE NUMBER OF TRIALS NECESSARY FOR LEARNING ON THE STANDARD FORM OF PRESENTATION AND RESULTS OF STANFORD-BINET EXAMINATION

The number of trials necessary for complete learning is the basis of scoring the results of this experiment. The number of trials necessary for complete learning was correlated with Stanford-Binet mental ages for various age groups, boys and girls combined, and for age five and one-half years, boys and girls separate.

Of the 132 children who completely learned the material according to the standard form of presentation, 113 were given an individual Stanford-Binet examination by the examiner who carried on the learning experiment. Nineteen of the children were given the Stanford-Binet examination by one of three other examiners of the Iowa Child Welfare Research Station. One of these examiners gave the Stanford-Binet examination to four of the preschool children, another, to one preschool child and five junior primary children, and the third, to nine junior primary children. Each of the sixty-two kindergarten children included in the total of 132 children was given the Stanford-Binet mental examination by the examiner who carried on the learning experiment. The factor of the personal equation of the examiner is therefore reduced considerably. All of the sixty-two Stanford-Binet examinations of the kindergarten children were given during the period in which the learning experiment was being carried on. A few of the preschool and junior primary children were subjects of the learning experiment a few months after having been given a Stanford-Binet mental examination. The mental age was corrected up to the time of the learning experiment in all cases in which there was a difference of one month or more in chronological age between the time of the Stanford-Binet examination and the time when the child was a subject of the learning experiment.

Mental Age (Stanford-Binet) by Groups

Of the thirty-two preschool children who completed the learning of the material according to the standard form of presentation, one child was in the two-year age group, three were in the three-year age group, seventeen in the four-year age group, and eleven in the five-year age group. Twenty-six junior primary and sixty-two kindergarten children were in the five and one-half-year age group. The one child in the two-year age group and the three children in

the three-year age group were disregarded, and a correlation was found between the number of trials necessary for complete learning on the standard form and the results of the Stanford-Binet examination of the fifty-four four, five, and five and one-half-year-old children of the Preschool Laboratory and the Junior Primary Group. By the method of partial correlation for eliminating the influence of mental age, the correlation between chronological age and number of trials required for complete learning for these fifty-four children was —.27 ± .08; by the method of partial correlation for eliminating the influence of chronological age, the correlation between mental age and number of trials required for complete learning was —.47 ± .07. These correlations show that the number of trials necessary for complete learning correlates better with mental age than with chronological age. The negative correlations must be interpreted as follows: on the Stanford-Binet, the higher the mental age in relation to the chronological age, the better is the child's performance; whereas, for the learning material, the fewer the number of trials required for complete learning, the better is the child's performance. Thus, instead of having an increase in score to denote superior performance on the learning material, as is the usual method of scoring psychological tests, a superior performance on the learning material is denoted by a decrease in the number of trials required for complete learning as compared with the number of trials required for complete learning when the performance is either average or below average. The correlation —.47 ± .07, when the influence of chronological age is eliminated through the method of partial correlation, shows that there is a relation to that extent between the two variables, mental age and number of trials, and that the higher the mental age, the fewer the number of trials required for complete learning of the association reaction learning material.

Correlations were found also between the number of trials required for complete learning and mental age for the two groups of children of the chronological age five and one-half years (Table 12). For twenty-six junior primary children the correlation is —.48 ± .10; for the sixty-two kindergarten children, —.52 ± .06. The correlations, therefore, are very similar to each other, and are similar also to the correlation —.47 ± .07 found between the number of trials and the mental age of the fifty-four preschool and junior primary children.

TABLE 12
Correlations between Number of Trials Necessary for Learning on Standard Form of Presentation of Material and Results of Stanford-Binet Examinations

Children		Number of children	Age, Years	r	P.E.	Age constant			
						Chronological		Mental	
						r	P.E.	r	P.E.
Sexes combined									
Preschool		54	4, 5, 5½			—.47 ± .07		—.27 ± .08	
Junior primary		26	5½	—.48 ± .10					
Kindergarten		62	5½	—.52 ± .06					
Sexes separate									
Junior primary and kindergarten	Boys	43	5½	—.58 ± .07					
Junior primary and kindergarten	Girls	45	5½	—.40 ± .08					

Mental Age (Stanford-Binet) by Sexes

Correlations were computed by sex for the eighty-eight junior primary and kindergarten children in the five and one-half-year age group. It had not been determined how nearly evenly the sexes were divided until the records were being separated for computing these correlations for each sex. The sex distribution of this group is as follows:

	Boys	Girls	Total
Junior primary	8	18	26
Kindergarten	35	27	62
	43	45	88

The correlation between the number of trials required for complete learning and the mental age of the boys and girls of the five and one-half-year age group is —.58 ± .07 for the forty-three boys, and —.40 ± .08 for the forty-five girls. The difference between the correlation between the number of trials and mental age for the boys alone and the correlation between the number of trials and mental age for the girls alone is greater than the difference between the correlations for the junior primary and kindergarten children of the five and one-half-year age group, when the sexes are not considered separately, and the correlation for boys is higher than for girls.

All of the correlations based upon the number of trials required for complete learning of the association reaction learning material and mental age are found to be negative and must be interpreted as has been explained. The correlations are not very high, but in each case the correlation is a sufficient number of times larger than the probable error for the correlation to be regarded as significant. Table 12 shows the correlations between the number of trials necessary for complete learning on the standard form of presentation of the association reaction learning material and the Stanford-Binet mental ages of the various groupings of children.

CORRELATIONS BETWEEN THE NUMBER OF TRIALS NECESSARY FOR LEARNING ON THE STANDARD FORM OF PRESENTATION AND VARIOUS PSYCHOLOGICAL TESTS ON CHILDREN OF THE FIVE AND ONE-HALF-YEAR AGE GROUP

Of the twenty-six junior primary children of the five and one-half-year age group, records were available on the Detroit kindergarten test and on two of the Pintner-Paterson performance tests (the Goddard-Seguin form board and the manikin test) for twenty-

two, and a record on the Montessori cylinders test for nineteen of the children. Each of these eighty-five individual tests had been given to the junior primary children by the examiner who carried on the learning experiment. Here again, the factor of the personal equation of the examiner may be regarded as of negligible influence

TABLE 13
Correlations between Number of Trials Necessary for Learning on Standard Form of Presentation of Material and Scores on Various Psychological Tests on Children of the Five and One-Half-Year Age Group.

Children	Test	Number of children	r	P.E.
Junior primary	Detroit kindergarten	22	—.26	±.13
Junior primary	Goddard-Seguin form board	22	.12	±.14
Junior primary	Manikin	22	—.05	±.14
Junior primary	Montessori cylinders			
	Board 1	19	.21	±.15
	Board 2	19	.32	±.14
	Board 3	19	.26	±.14
Kindergarten	Detroit kindergarten	54	—.33	±.08

when correlating the scores on these various psychological tests with the number of trials required for complete learning of the material of the association reaction learning experiment.

Of the sixty-two kindergarten children of the five and one-half-year age group, a record was available on the Detroit kindergarten test for fifty-four children. These children were from three kindergartens so three different persons had administered the Detroit kindergarten test to the children in this group, since each kindergarten teacher gave the test to her own pupils. The personal equation of the examiner is not, therefore, a constant factor in these records.

Table 13 shows the correlations between the number of trials required for complete learning according to the standard form of presentation of the learning material and the scores on the Detroit kindergarten test for junior primary and kindergarten boys and girls of the five and one-half-year age group, and on the Goddard-Seguin form board, manikin test, and Montessori cylinders test for the junior primary boys and girls of the same age group.

Detroit Kindergarten Test

As shown in Table 13, the correlation between the number of

trials required for complete learning and the scores on the Detroit kindergarten test for the fifty-four kindergarten children is —.33 ± .08. This correlation indicates that the children who are above average in mental age require fewer than the average number of trials for completing the learning. The correlation is a little more than four times the probable error so that the correlation may be regarded as significant.

A different situation is found when the number of trials required for complete learning is correlated with the scores on the Detroit kindergarten test for the twenty-two junior primary children. The correlation in this case is —.26 ± .13. The correlation is only twice the probable error and therefore it may not be regarded as significant.

Two Performance Tests (Pintner and Paterson)

The Goddard-Seguin form board was given to twenty-two of the twenty-six junior primary children. The number of trials required for complete learning was correlated with the shortest time required for one of three trials on the Goddard-Seguin form board test. For this test, the shorter the time, the better is the performance, just as in the case of the learning material, the fewer the number of trials, the better is the performance. The correlation in this case is positive, but it is too small to be of any significance. The correlation between the number of trials required for complete learning and the shortest time required on one trial of the Goddard-Seguin form board test is .12 ± .14.

The manikin test was given to the same twenty-two junior primary children to whom the Goddard-Seguin form board test had been given. The number of trials for complete learning was correlated with the score on the manikin test. In the manikin test, the higher the score, the better is the performance, whereas in the learning experiment the fewer the number of trials, the better is the performance. The correlation is negative again. It is, however, too small to be of any significance, —.05 ± .14.

Montessori Cylinders

Nineteen of the twenty-two junior primary children were given the three parts of the Montessori cylinders test. The number of trials required for complete learning was correlated with the score on each of the three parts of the Montessori cylinders test. On this test, the higher the score, the better is the performance. The correlations, however, were positive. In no case is the correlation of any

significance. For board 1 the correlation is .21± .15, for board 2, .32 ± .14, and for board 3, .26 ± .14.

The correlations between the number of trials required for complete learning according to the standard form of presenting the association reaction material and the results of the various psychological tests included here are of no significance with the exception, perhaps, of the correlation between the number of trials and the scores on the Detroit kindergarten test in the case of fifty-four kindergarten children, when the correlation is —.33 ± .08.

CHAPTER IV

STUDY OF SPECIAL CASES

In the statistical analysis of data, interesting features of individual records are hidden. In order to bring out some of these interesting points, a selection has been made of the records of twelve children who learned the material according to the standard form of presentation. In one case the learning was on alternate days; in all other cases, on successive days. These records include those of four children who failed to learn the material within twenty trials and of eight children who completed the learning. The cases of failure demonstrate the part played in the learning process by factors such as immaturity, emotional instability, and memory defects. The records of successful learning demonstrate unusual rapidity of some children in forming associations; the ability of the youngest child to complete the learning because of her superior mental development; consistent alternation of gains and plateaus, in one case; persistency for six trials in the confusion of two blocks after two successive perfect scores of 20, in one case; and marked resemblance in learning the standard form and learning when associations are interchanged, in a number of cases.

Analysis of Four Cases of Failure in Learning the Material

Eleven children who were given the material for learning in this experiment failed to make a perfect score within the limit of twenty trials. Although the records of these eleven children had to be discarded in the analysis of the results of the experiment since only records of completed learning were included, these cases of failure are very interesting from the standpoint of analysis of individual reactions to the material, and for the light which they throw upon the learning process in cases in which a certain amount of learning is achieved but the learning is not completed within the requirements of the experimental situation.

Of the eleven cases of failure, nine occurred among the preschool children, that is, among the youngest of the subjects of the experiment. The material is undoubtedly too difficult for two-year-old children as a group, although one exceptionally bright child of this

age completed the learning within the number of trials set as the limit. It is interesting to note that of the eighty-eight children of kindergarten age, the total number of junior primary and kindergarten children combined, there were two cases of failure only and these may be accounted for by special defects in each case.

The records of four of the children, two boys and two girls, who failed to complete the learning within twenty trials, have been selected for the purpose of individual analysis. Figure 24 shows the learning curves of these four children.

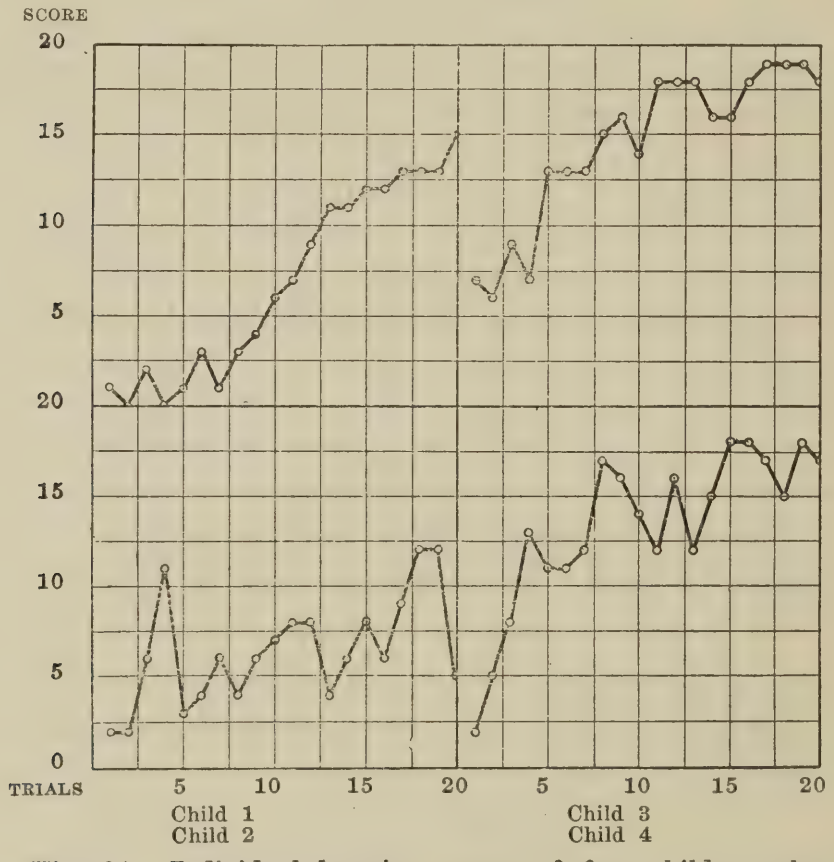

Fig. 24. Individual learning curves of four children who failed to learn the material within twenty trials according to the standard form of presentation on successive days. Child 1 and Child 4 are girls; Child 2 and Child 3 are boys.

Child 1

Sara, who belonged to the Preschool Laboratory group, was chronologically two years and eight months old at the time of the experiment. Her mental age then was three years and three months, and her intelligence quotient 123. Failure in this case was due, undoubtedly, to immaturity. The task of learning twenty associations within twenty trials was beyond the stage of development of her ability at that time. The learning curve for this child shows, however, several interesting features. For trials 1 through 7, scores include three scores of

1, two scores of 0, one score of 2, and one of 3. No doubt, during these trials at the beginning of the experiment, the whole situation was too large and too complex for the child to grasp, with the result that there was probably a buzzing confusion in her mind as to just what was expected of her. Successes during trials 1 to 7 may be regarded as due to chance with the possible exceptions of the association of block 1 and the picture of the clock and block 18 and the picture of a flower, since from the early trials these occurred correctly more times than any other association. After the seventh trial, the situation evidently began to become clearer in Sara's mind, and from the seventh through the thirteenth trials there was a steady increase of score that shows a daily increase of 2 points during four of the six intervals between these trials and an increase of 1 point between each of the trials for the two other intervals.

In plotting Sara's learning curve (Child 1, Figure 24) no plateau was found up to the thirteenth trial, when a plateau occurs that extends over two trials; this is followed by an increase of 1 point after which there is another plateau extending over two trials, then another increase of 1 point followed by a plateau lasting for three trials. On the succeeding trial, the score increases by 2 points, reaching a total of 15. This is on the twentieth trial, however, when the experiment was discontinued. Although this curve represents failure as judged by the criteria used here for complete learning, it shows learning quite plainly and definitely. From the continued period of increase in the amount learned and from the fact that the shape of the curve from the seventh trial through the twentieth is very similar to many of the curves of completed learning, it seems justifiable to assume that this child would have completed the learning within perhaps five more trials.

Sara seemed interested in the material and paid close attention while the examiner showed it to her. Almost every time a picture and its corresponding block were presented to her, she nodded her head as if she understood the directions, but evidently she either did not understand them or, because of immaturity, was unable to form the necessary associations. The latter seems the more plausible reason. During the early trials, her responses consisted mainly in picking up blocks at random, especially the blocks directly in front of her, and frequently she picked up the blocks in the order that they had been placed upon the table. Beginning with the seventh trial, when Sara began to know some of the associations, she sometimes responded with an incorrect block, put it down quickly, and reached for the correct one. From this trial on, she really looked for the correct blocks and showed less of the tendency to pick up one block after another as they lay before her. She showed perseverance in her responses, particularly with blocks 1 and 3. In the beginning, she was more interested in the pictures than in connecting them with the blocks. On the second trial she named several of the pictures, as "trees," "star," "little birdie" [flying bird], "round wheel," "house" [windmill], and during almost every trial thereafter she named these and others of the pictures. After a few trials she responded by placing the blocks upon the pictures as if trying to fit them together. On the twelfth trial, Sara made a comment that showed she was definitely comparing blocks and pictures; when the examiner showed her the picture of the maple leaf and block 10, the five-pointed star, Sara pointed to the star and said, "Too small." On the next trial she made a similar comment by say-

ing in regard to block 14 and the picture of the sail boat, "That's too little." After this she commented "Just like it" for several pictures and their corresponding blocks.

Child 2

John, in the Preschool Laboratory, was chronologically three years and seven months old at the time of the experiment. His mental age then was three years and nine months, and his intelligence quotient 104.

John's learning curve (Child 2, Figure 24) is the most eccentric of the total number of 203 curves plotted. When the examiner showed it to one of the other workers in the Laboratory and to the child's teacher, each of whom had known, worked with, and observed the child over a much longer period of time than the examiner, one of the immediate remarks was, "Well, isn't that just typical of John. He's such an erratic child." Their further remarks and the examiner's observations seem to justify the statement that the learning curve of this child may be regarded as typical of his reactions to many other situations and may be looked upon as a profile of the child without overestimating and overinterpreting what the curve represents.

One day John tries to hit every other child in the room; the next day, he plays so quietly at the sand table, or with some other equipment in the laboratory, that one acquainted with the group assumes at first that he is absent. Not infrequently he incurs the displeasure of the children in the group because of striking them and because of his bullying attitude, so that later when he goes around the room and asks each child, one at a time, to play with him, he is refused by every child. At times he is extremely noisy, shouting aloud and banging toys or furniture or anything that happens to be near at hand; at other times he is very quiet. He and two or three others came to school daily in a taxicab. It was a usual occurrence for this little boy to hit a certain little girl who came in the taxicab also. The driver had John ride on the front seat with him for several days; when John was allowed again to ride with the other children, he again began hitting the little girl who previously had been the object of his blows, but there were days intermittently when he would ride with the children without creating any disturbance.

John's learning curve begins with a plateau on a score of 2 points. This is followed by two rapid rises, so that by the fourth trial he has scored 11 points. The record of the next trial drops, however, to 3 points, a greater decrease than in any other of the total of 203 learning curves plotted. The score of 11 obtained on trial 4 is not reached or surpassed until trials 18 and 19, each of which has a score of 12 points. Between trials 4 and 18, there is a continual fluctuation in score. On the twentieth and last trial, there is a very unusual drop in score from 12 to 5. John did not seem bored with the material nor was he ever reluctant to come to "play the game" with the examiner. In fact, he is rather the type of child who enjoys adult attention and came very willingly to the examining room each day. During every one of the twenty trials he was talkative and usually kept up a running conversation during the entire experiment. Several times, on the first trial and on a few successive trials, after John had made a response, he picked up another block and asked, "Where's the picture that goes with this one?" Beginning with the second trial, when

he named "the star" and other blocks and called the picture of the bell "a dinner bell," he very often named either the pictures or the blocks. He seemed to observe resemblances carefully while the examiner showed him the blocks and pictures. On the fourth trial when the examiner showed him the picture of the six-spoked wheel and held up block 15 he said, "This one [picking up block 1] should go with that." Actually the shape of block 15 is more like the shape of the picture of the wheel than that of the block that is to be associated with it. In responding, however, John gave the correct block. The next day, when the examiner showed the picture of the six-spoked wheel and held up block 15, John again picked up block 1 and asked, "Why wouldn't this be the right one?" and this time responded with block 1. Frequently, he fitted the block upon its corresponding picture, particularly if it were an association that had been definitely formed. Sometimes he asked, as he placed a block upon its corresponding picture, "Does this fit with this one?" or "Will it fit on that picture?" "Will it fit on there?" Sometimes he tried to fit the wrong block on a picture as, for example, when he responded with block 3 instead of block 16, but turned block 3 in a perpendicular position instead of horizontal, the way in which it is used. In this turned position it more nearly resembles block 16 and could be made almost to fit over picture 16.

This child seemed at all times interested in the "game" and responded quickly. During the first trial he said that he liked the blocks and volunteered the information that he had some blocks at home. The next day when the examiner asked him to come out with her to play a game, he asked, "Going to play with the blocks?" and seemed pleased by the prospect. Throughout his twenty trials this child seemed interested and paid close attention to all of the directions, coöperated well, and responded without urging, but continued to make poor records.

Child 3

One of the two kindergarten children who failed to learn completely the material used in this experiment is George. At the time of the experiment, he was chronologically five years and five months old, mentally five years and four months, and had an intelligence quotient of 98. He is a dull appearing child.

During the learning experiment, George nodded his head each time the examiner showed him a block and the corresponding picture. While he was responding with the blocks, he worked quietly, looked carefully for each block, and evidently was trying very hard to make correct responses. His learning curve (Child 3, Figure 24) is a rather unusual one. It shows three plateaus, each of which extends over a period of three trials and another plateau that extends over two trials. At five points on the curve there is a decrease in score and at two of these points the decrease comes immediately after a plateau that extends over three trials. Fluctuations of this type in George's learning made the examiner suspect a memory defect. The examiner asked his teacher for information concerning him and was told at once that the child's memory seemed to be defective. When carrying on a project that could not be completed in one day most of the children in the group would start in the next day with the work where it was discontinued. George seemed never to remember from one day to the next, however, so that it was necessary each day to give again to

him all of the directions that had been given the previous day. This and similar instances of inability to retain material had made the kindergarten teacher feel doubtful of promoting him to the first grade. It would be interesting to follow this child for a few years to note whether or not his learning on school work follows the form of the curve that represents his record on the association reaction learning.

Child 4

The second of the two kindergarten children who failed to learn completely the material of this experiment was Gladys, who was, at the time of the learning experiment, five years and four months old chronologically and mentally five years and six months. Her intelligence quotient was 103.

Gladys seems to be of the emotionally unstable type. She showed a marked tendency toward indecision; in almost every trial she changed several responses. Frequently she changed a response two or three times. When Gladys was mentioned to the teacher, she at once began to comment upon the child's defective memory and told of several situations in which the quantity and quality of the child's work fluctuated markedly from day to day. At the time the examiner was collecting data on the learning experiment the kindergarten teacher was having the children learn the names of various birds by means of large colored pictures of each bird. The names of seventeen different birds had been taught to the class and many of the children could identify the entire series. The teacher said that on one day Gladys would be able to recognize as many as fourteen of the bird pictures and on the following day only three, or perhaps four.

Gladys' learning curve (Child 4, Figure 24) shows the same number of points at which there is a decrease in score as is found in George's learning curve. In the case of Gladys' record, however, the amount of each decrease is larger generally and at one time there is a drop of 5 points. Each time the examiner presented the material to her she nodded, but seldom made comments. Almost all of the children of Gladys' age learn the material in less than nine trials. After the twelfth trial, the examiner asked Gladys if she were tired of playing the game. She smiled, shook her head vigorously, and said, "No, I like this game". Gladys did not show at any time a disinclination to come "to play the game".

In this case, as in the preceding, the child's teacher mentioned the noticeable memory defect and the tendency for both children to show marked fluctuations between good work on one day and very poor work on the following day. Undoubtedly, memory defect is the most important factor in determining the failure of these two children to learn the required associations. Learning is directly dependent upon memory, upon the fact that past experiences are preserved within the psychophysical organism in the form of bonds ready to act when a given stimulus is presented. Unless the bonds have not been formed sufficiently strong, a repeated presentation of the stimulus will not call forth the correct response.

Analysis of Four Cases of Success in Learning the Material

In addition to the curves discussed in Chapter III that follow the typical curve for the learning of the material used in this experi-

ment, there are certain individual curves of successful learning that are especially interesting. The curves of four children who completed the learning of the association reaction material according to the standard form of presentation (Figure 25) have been selected for analysis. All of these children learned the material by presentation on successive days.

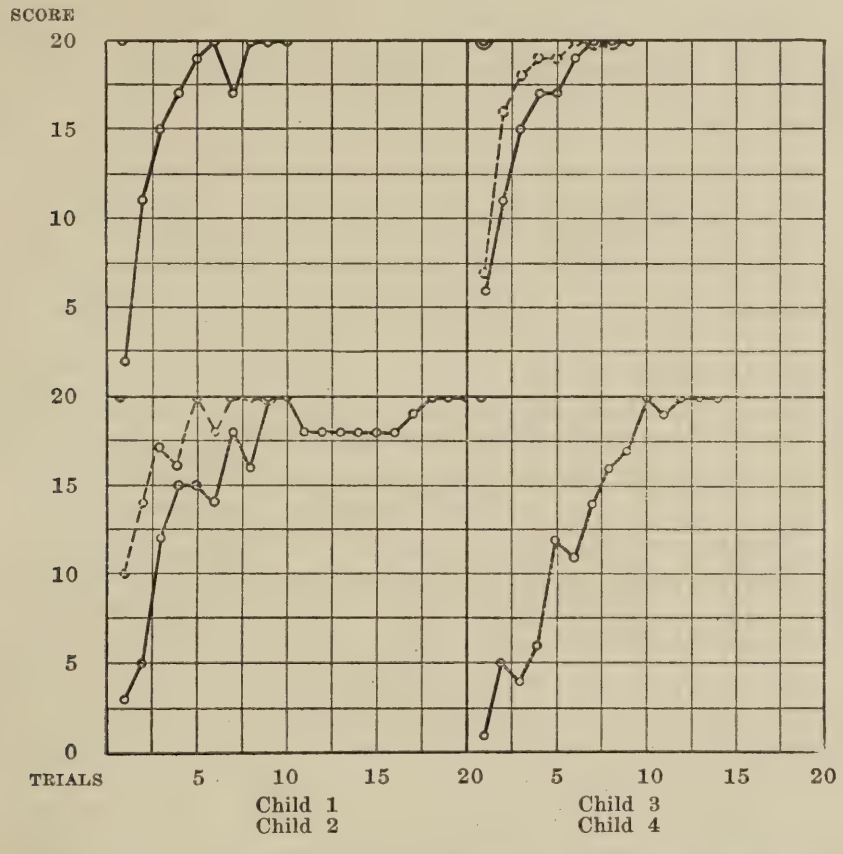

Fig. 25. Individual learning curves of four children who succeeded in learning the material within the limit of twenty trials according to the standard form of presentation on successive days (——). Child 2 and Child 3 also learned the material according to the standard form interchanged (- - - -). Child 1 and Child 2 are girls; Child 3 and Child 4 are boys.

Child 1

The record card of Alice, in the Preschool Laboratory, shows that at the time of learning the association of blocks and pictures she was three years and eleven months of age, had a mental age of four years and six months, and an intelligence quotient of 117. Her learning curve (Child 1, Figure 25) is very interesting. It begins with a score of 2, reaches 11 on the second day, and rises to 15 on the third day. At this point, the large increase between trials ceases; there is an increase of 2 points for two successive trials, followed by an increase of 1 point that brings the score to 20. After having attained one perfect trial, the score falls back 3 points. These are regained on the next trial, however, and

this score of 20 is maintained for two more successive trials and thus the learning is completed. The curve has risen from score 2 to the first perfect score of 20 in six trials, and undoubtedly the instability of certain of the associative bonds is due to the rapidity with which they were formed. This accounts for their breaking down, as shown in the decrease of 3 points in score after one perfect performance.

Child 2

The learning curve of Elizabeth (Child 2, Figure 25), in the Preschool Laboratory, who had had her fifth birthday a few days before beginning the learning experiment, shows some unusual features. At the time, her mental age was five years and six months, and her intelligence quotient 108. Her record begins with a score of 3. It increases to 5 points on the second trial, and then has a rapid rise to 12 on the third trial. The next score is 15 points. A plateau occurs at this point, followed by a decrease in score. An increase of 4 points occurs on the next trial, but this is followed by a decrease of 2 points. The score then increases 4 points, which brings it to 20, where it remains for two successive trials. Then it drops 2 points and remains at 18 for six consecutive trials before rising to 19, then 20, and remains there for three consecutive perfect scores. This child completed the learning on the twentieth trial, the maximum number of trials allowed for learning, although trials 9 and 10 yielded a score of 20 points also. The plateaus and the several decreases after large increases in score seem to uphold the theory that both the plateaus and the decreases in score are due to the instability of certain of the associations that have been formed so rapidly and that time is needed for the automatization of the bonds. The outstanding feature of this learning curve is the plateau of six trials on score 18 that follows two successful perfect trials. The plateau is due to a persistence of confusion between blocks 5 and 15, the pentagon and the hexagon. An incorrect association for these two blocks, that consisted in a confusion between the two, had been formed early in the experiment and it was difficult for the newer, correct association to eliminate the earlier formed incorrect associations.

After Elizabeth had three successive perfect scores she was given the check on learning, on which she made a perfect score. During the check, she responded very quickly and without even one hesitation. She held her hands behind her and each time brought her right hand forward to touch the picture. Just before completing the learning, it seemed that she had localized the position on the table of certain of the blocks and this seemed to carry over to the situation in which the material was presented as a check on learning. Elizabeth walked up and down as she made her responses and seemed to know whether to go toward the left or toward the right when a picture was needed. The material was presented to Elizabeth according to the standard form interchanged. The learning of the interchanged associations was accomplished in less than one half of the number of trials required for the original learning. The learning curve for the learning of reversed associations is shorter, but resembles in general the learning curve for original learning. Both show decreases in score following upon large increases. Although the curve for learning the interchanged associations shows decreases it does not show plateaus.

Observational notes on Elizabeth's records state that she always paid close attention and showed much interest while the examiner presented the material to her. Beginning with the second trial, she looked carefully back and forth between picture and block as the examiner held them side by side before her. When it was Elizabeth's turn to respond, she searched carefully for each block. At the end of the second trial, she remarked that she liked the game and when the examiner said that she would "play the game again," Elizabeth seemed pleased and inquired, "Tomorrow?" At the beginning of the fourth trial, she remarked again that she liked the game, and added, "These blocks aren't so hard, are they?" She looked over the blocks carefully before picking up each one. By the fifth trial, she had formed fifteen correct associations. Several of the incorrect associations are interesting. They demonstrate the child's ability to observe resemblances, although at times the wrong cue is followed and the wrong response results. For example, blocks 5 and 15, blocks 8 and 17, and blocks 10 and 20 were confused. Almost all of Elizabeth's errors were due to a close but incorrect resemblance of blocks. Beginning with the fifth trial, she responded quickly and seemed to be very sure of her responses. She picked up each block and firmly laid it down directly in front of the examiner. Sometimes while the examiner was going through the series of blocks and pictures, Elizabeth named each picture, as "That's a clock," "That's a train," and later when she responded with the blocks she called the block by the name of the picture, as "kite," "drum," "bell," "wheel." This was done by a number of the children.

When learning had been completed and the material was presented to Elizabeth for interchange of learned associations, she responded with ten correct blocks on the first trial. She was very thoughtful in her responses. Several times during this first trial she was somewhat slow in responding, but after these hesitations she usually gave correct responses and appeared to be thinking very attentively during her silences. On this first trial of interchanged associations, she showed only one persistence of a former association. This was in the case of the picture of a flower and block 8. She worked quietly, but asked a few times, "Is this the one that goes with that now?" or "Is this the right one?" When she came to the examining room for the fifth trial, she said, "I got them all right yesterday, didn't I?" The score on the day before had been 16, but she scored 20 that day. When she had almost finished this trial she remarked, "I'm doing it quicker. Aren't I doing it quicker?" Just as on the original learning, so on the learning of interchanged associations, Elizabeth responded each time by reaching over both rows of blocks, and by placing the block before the examiner.

On the sixth trial, as soon as she sat down before the blocks, she picked up blocks 11, 12, and 13, and said, "These are the ones," evidently referring to the ones that come at the beginning of the material when it is presented for learning of interchanged associations. "Does this go with the train?" and she held up block 13. "Does the tree go next?" and she reached over and picked up block 14. She responded quickly and accurately, and completed the learning of interchanged associations in nine trials. Twenty trials had been necessary for her to learn the material completely by the original form of presentation.

CHILD 3

Paul's learning curve (Child 3, Figure 25) shows that he learned the twenty associations quickly for a child of his age. He was in the Preschool Laboratory. At the time of the experiment he was four years and eight months old chronologically. His mental age was five years and four months, and his intelligence quotient 114. After Paul had completed the learning by the standard form he was given the material to learn by the method of interchange of associations. He learned the required associations by this method even more quickly than he had learned them according to the standard form. Paul's scores for learning by each of the two methods are remarkably similar. Nine trials were required to complete the learning when the material was presented according to the standard form of learning, and eight trials when the associations already learned were interchanged. There are no crossings of these two curves, as is generally observed. Seven of the nine scores on learning according to the standard form are paralleled by the scores on learning the interchange of associations. Since learning on interchange of associations is accomplished in one less than the number of trials required for the original learning, there is really one point only at which the learning curve for the original learning according to standard form of presentation is not paralleled by the learning curve for the interchange of learned associations. The latter curve is above the former at all points until the two curves coincide when complete learning has been attained.

Paul saw resemblances between pictures and blocks on the first trial and tried to fit several of the blocks upon their corresponding pictures. In the meantime he made remarks, such as "That's the drum" and "That just fits," as he responded by placing block 6 upon the picture of the drum. Once when he started to make an incorrect response he said, "No, that doesn't fit it." He remarked, when responding with block 13 to the picture of the flying bird, "That's the wing," indicating that he had observed the similarity between the points on the picture of the bird's wings and the points on the corresponding block. The next day when Paul came into the examining room for the second trial and saw the blocks, he said at once, "Here are those blocks that I played with before. I remember the game." Then he added thoughtfully, "But I don't remember what is the picture that goes with each block," and began picking up blocks and naming them. Paul paid very close attention while the examiner showed him the series of blocks and pictures. He nodded his head and said "Yes" almost every time the examiner showed him a picture and the block that corresponded with it. He responded by placing nearly every block upon a picture, and said, "I put that one on," "That doesn't cover it all up," or "That just covers the picture up." When the examiner showed him the picture of the evergreen trees, he said, as he picked up the triangular block, block 3, " 'Cause that's a Christmas tree, and that's why that [triangular block] goes with that 'cause it's *this* way," and he ran his finger up and down the two sides of the triangle and on the corresponding part of the picture of a tree. He made remarks about certain of the blocks, such as blocks 12 and 18, about each of which he said, "That's an easy one" as he handed the block to the examiner.

On the first trial with the interchanged blocks and pictures, Paul said several times, "This *used* to be the one," and then gave the correct response according to the method of interchange of associations. When the first trial was over

by this new method, he smiled and said, "I just like this funny game," and seemed amused by the fact that a certain block that formerly was paired with a certain picture was now paired with a different one. On the third trial, as soon as he entered the examining room, he picked up block 11 and said, "*This* is the one and this [picking up block 1] used to be the one that went with the clock." He responded very quickly and accurately. His score was 18, although it was only his third trial on the interchange of associations.

Paul is an alert, talkative child who seemed very much interested in "the game" at all times. He responded by looking carefully for the blocks and from the first trial did not pick up the blocks at random. He showed a great deal of interest in his own success and frequently asked the examiner, "Have I got most of them?" or "Have I got them all yet?" Sometimes he said to the examiner, as when he was half finished with trial 2, "I'm getting them all right today." His score on this trial was 11.

Child 4

Fred had the highest intelligence quotient of any boy in the Preschool Laboratory. At the time of giving him the learning material, he was two years and eleven months of age, and had a mental age of four years and six months. His intelligence quotient was 153. Fred is very talkative and has a remarkable vocabulary for a child of his age.

Fred's learning curve starts at 1, jumps to 5, and after this rise falls back. Next comes a slight increase, followed by a large increase, 6 points, but a decrease follows it again. Then the curve goes upward for four trials, at which it reaches the score of 20, but falls back again. On the next trial the score of 20 is regained and maintained for three successive perfect trials. Each time that a decrease occurs, it is after a large increase. When the examiner came into the group play room the day after Fred's second trial Fred came up, took the examiner by the hand, and said he wanted to go to "play the game." As soon as Fred saw the first picture and before the examiner had begun the directions, Fred picked up block 1 and placed it upon the picture. Fred was very much interested and enthusiastic while the examiner showed the blocks and pictures, and while he was responding with the blocks. After he had responded correctly with block 10, Fred picked up blocks 13, 18, and 19, and asked for each, "We haven't come to this one yet, have we?" By the fourth trial, certain associations had been formed correctly, but at first when Fred did not know which block to pick up he responded with any block near at hand, without looking around. When Fred came to the examining room the day of the sixth trial, he picked up the triangular block, block 4, and said, "Let me see the Christmas tree" and then picked up the five-pointed star, block 10, and said, "Let me see the pretty leaf." This was before the examiner began to show him the pictures and blocks. His interest in the material lasted throughout the learning experiment. On his fourteenth and last trial, he announced to the examiner, "All ready for the game," as soon as he came into the examining room. This may be considered as typical of Fred's attitude; he is always ready to enter into any project. He is one of the youngest children in the preschool group, but is very mature for his age and talks like a child much older. He is a good example of a very young child's completion of the learning because of superior mental ability. Child 4, Figure 25 shows Fred's learning curve.

Summary

The cases selected for discussion in this chapter are only a few that have outstanding features that make them worthy of special attention. It would be interesting to know how far the curves of each child represented here will be typical of his learning reactions in other situations. Will Fred, the very young child who successfully learned the association reaction material, continue to stand out as superior to others in the group? Will John, because of his emotional instability, continue to show marked fluctuations from day to day in his ability to learn so that he will become the exasperation of the various teachers in whose classes he will be? In like manner, will those children who learned the material with unusual rapidity continue to be at the head of their classmates?

CHAPTER V

REACTIONS OF A SELECTED GROUP OF ADULTS TO THE LEARNING MATERIAL

The comments of the children gave many clues as to how they formed the necessary associations of block and picture during the course of the experiment. The children, of course, could not be expected to introspect purposely, but many of their comments take on the nature of introspections. Shortly after beginning to use the learning material, the examiner asked a few of the junior primary children at the end of a trial on which the score was 20 or almost 20, "How do you know which block goes with each picture?" or, holding up a certain picture and its corresponding block, asked, "How do you know this is the right block that goes with the picture?" The children could not tell when asked the question directly. Several children who voluntarily pointed out resemblances of blocks and pictures could not explain when asked to tell how they knew the correct blocks when shown the pictures. After a few attempts only, the examiner decided not to ask the children these questions and to rely wholly upon the information volunteered by the children in regard to how they associated certain blocks with certain pictures.

It was thought that if the material were presented to a few adult subjects who were well qualified to give introspections as to how they formed the associations, and to state what to them seemed to be the order of difficulty in forming the associations, an interesting comparison might be made between the comments of the children and the introspections of the adults. Seven adults trained in introspection agreed to act as subjects. Subjects A, D, E, and G are graduate students who hold appointments as research assistants in psychology; subjects B and C are graduate assistants in psychology, and subject F is a widely known professor of psychology. Two of the graduate students received the degree of doctor of philosophy a few weeks later, and each of the others has had more than the required work for the degree of master of arts. Subjects A, B, D, and E are women; subjects C, F, and G, are men.

The material was presented once only to each adult according to the standard form of presentation. After the subject had responded

to each of the twenty pictures, the examiner showed one at a time each block and its corresponding picture, and asked the subject to state exactly how he formed the association between block and picture in each case, and to introspect on the formation of the association, as fully as possible. Although the scores of the adults are not taken into account in analyzing their introspective reports, it is interesting to note that of these seven highly selected adults, two only scored 20, one scored 19, one 18, one 17, one 16, and one 14. It seems, therefore, that the material is such that even for these adults there is an opportunity for learning to take place.

Reports of Introspection of Adults

A few general statements will be made before taking up responses to specific blocks and pictures. Both adults and children have certain factors in common in the process of forming the required associations, as shown from a comparison of comments of children and reports of introspections of adults.

The adults mentioned specifically certain similarities between blocks and their corresponding pictures, and the cases in which the similarity seemed most obvious to the adults were also those mentioned most frequently by the children. Almost every child at some time during the experiment responded by placing certain of the blocks upon their corresponding pictures and tried to fit the blocks to the pictures. As the directions say nothing about a resemblance between block and picture, the response of trying to fit the block to the picture is due obviously to the child's perception of the existing similarity. Some children tried to fit almost every block to its picture and showed quite plainly that they were pleased when the blocks and pictures were very similar in outline and that they were annoyed when certain of the blocks did not correspond so well to their respective pictures. Each of the seven adults mentioned "a tendency to try to fit the block to the picture," or, a tendency to say inwardly "The same" or "The same; the block fits the picture." In the case of the adults, it was a mental fitting of block to picture, but in the case of the children, it was an actual placing of the block upon the picture. Each of the adults expressed a feeling of annoyance in the cases of most dissimilarity between block and picture. In the case of the children, annoyance over these dissimilarities was most generally shown by facial expressions. In certain instances, the child said, "Why doesn't that fit?" "That's not exactly the same"

or "That's larger," "That's smaller," or "That's too large," or "Too small," accordingly.

Many of the children named aloud all blocks that were of shapes with which they were familiar, such as "The star," "The round one," "The square one" or "The long one," as the rectangle was frequently referred to, or "The pointed one," as several children called the triangle. Undoubtedly, the names of the geometrical forms of many of the blocks were unknown to the children, since it would be difficult for most adults to call each of the twenty forms by its correct geometrical name. It would seem that the ability or inability to name the shape of the block would have its influence upon rapidity in forming the required association for the block. Two of the adults mentioned specifically a tendency to name each block as presented and mentioned the experiencing of a slight annoyance in each case when it was not easy to name the form of the block instantly. One of these two adults mentioned also a tendency to name the pictures and thus, in part, her formation of associations was based on association between name of block and name of picture, as "triangle-Christmas trees," as well as on similarity between the shape of the block and outline of the picture.

Each of the seven adults mentioned that in certain cases the similarity of the block as a whole to the picture was noted, and in other cases the association was between a small part of the block and a small part of the corresponding picture. The same holds true of the children in many instances, where comments such as, "This block is just like this picture" or, when one small element of the shape of block or picture was selected as, for instance, the sloping side of block 12 over which one child daily ran his finger and then ran it over the corresponding slope in the picture of the old-fashioned desk and remarked that they were "just alike" or "just the same." By both children and adults, block 8 was associated with the picture of the goblet because of the curve on each side and not by the resemblance as a whole. This holds true for several other blocks and their corresponding pictures. Four of the adults mentioned that in certain instances the resemblance was seen first as a whole and then as a resemblance between elements. Six of the adults mentioned that when a part was selected and responded to, there was a tendency to ignore all other parts.

Two of the adult subjects mentioned localization as an aid to learning. The position of the middle blocks or end blocks was fre-

quently thought of and noted as the experimenter picked up the block to show the subject with which picture it was to be associated and noted again as the experimenter replaced the block upon the table. It was found that a very few of the children, when all or nearly all of the correct associations had been built up, responded in part through localization of the blocks.

Six of the adults mentioned "subvocal verbalization" or "verbal inner speech" as an aid to learning; six mentioned kinaesthetic imagery in connection with certain of the associations, and four mentioned visual imagery. There is, of course, no data available as to these processes in the preschool subjects.

One adult subject mentioned that in the case of her responses it was "all or nothing." She either knew immediately or did not know at all which was the correct response. Her score was 16. Two other subjects stated that when they did not know which one was the right block they looked around for the block most like the picture and in some instances this resulted in arousing the association that had been in mind when the examiner was demonstrating which block and picture were to be associated, and therefore the correct response was given.

Comments made by the children and introspections on certain associations made by the adults in regard to specific blocks and pictures should be of interest in addition to the summarized statements that have just been given.

The association with which there was the most affective tone was between the picture of the flower and the corresponding block, block 18. Subject E stated, "The block was just the same general shape as the picture of the flower. The curves of the block and of the picture had a sort of soothing, restful effect." Subject F said, "That was a real joy. A kind of feeling of relief and satisfaction. The center of the flower faded out and the outline corresponded very nicely. There was a tendency to fit this block on the picture. The block sort of floated over on the picture and filled in the contour. It's the same size. The little lines in the center faded out and the effect was a feeling of satisfaction." Subject G's introspection on this association was as follows: "In several cases the general form of the block and picture are similar. This is true here. About the same size and same outline. It made me think of flowers in my grandmother's flower bed, her favorite flower. I had a visual image of my grandmother's flower bed. The association was very pleas-

ing.'' The children made less detailed comments on this association than was made by adults, but among the children it was this association more than any other that brought out comments indicative of affective tone. Their comments were very often a short statement, such as, ''That's a pretty flower,'' ''I like that flower,'' ''I'd like to have a pretty flower like that,'' ''That's the prettiest picture,'' ''I like that best of all.''

The association that brought out the greatest kinesthetic imagery was between block 13 and the picture of the flying bird. Subject C stated, ''In that association, it was a feeling of motion, so I looked for the block that nearest suggested motion to me even before you picked it up and showed it to me. The points didn't mean a thing to me, but now I see that one could associate the points on the block with the points on the wing of the bird and points on the bird's tail.'' Subject D combined both of these possible means of forming the required association but the feeling of motion predominated. She stated, ''I thought of this point and this point here on the block [indicating points on the bird's wings in the picture and points on the block]. There was a feeling of the instability of this (the block) and the flying bird. There was a motor feeling here—a certain tension of the muscles of the shoulder and I had a feeling of taking in my breath. It was a feeling of conscious expectation, a feeling of motion too. It was the bird as a whole flying and the whole block more than the point, but it was the two criteria. It was the flying bird. If the bird had not been flying it wouldn't have done any good. I wouldn't have found the association so easy. I got the idea of motion from the block too.'' Almost all of the children referred to the bird as the flying bird, but whether or not they had kinesthetic imagery is impossible to state.

The data from the adult reactions alone would form an interesting study which can not be gone into further here. Enough material has been given to show that there is a decided similarity in the methods of forming the associations by adult and preschool subjects.

Order of Difficulty in Forming the Required Associations

The order of difficulty in forming the required associations among the preschool children was found by an actual analysis of all correct and incorrect responses. In order to obtain, at least roughly, the order of difficulty in forming the required associations by adults,

each adult was asked, after having given his introspections, to arrange the blocks upon the table in what seemed to him the order of difficulty in forming the associations. As it would be extremely difficult, if not impossible, to arrange the twenty blocks in ascending order of difficulty, the subjects were told that they could group the blocks according to degree of difficulty. The subjects were not told any certain number of groups into which the blocks were to be

	A	B	C	D	E	F	G		1	2	3	4	5	6
○	1	1		1	1	1	1		6					
□	3	4		3	2	6	2			2	2	1		1
▭	3	3		2	2	2	1		1	3	2			
△	2	4		1	2	1	1		3	2		1		
⬠	1	1		5	6	2	1		3	1			1	1
⬓	2	5		3	4	5	2			2	1	1	2	
⬭	6	4		5	5	3	1		1		1	1	2	1
⧈	4	5		2	4	2	1		1	2		2	1	
⯃	1	3		2	2	5	1		2	2	1		1	
☆	4	6		3	6	6	6				1	1		4
⬯	1	2		4	3	4	3		1	1	2	2		
⬚	1	1		1	4	1	1		5			1		
▱	6	6		3	4	6	4				1	2		3
⏢	5	2		6	5	5	3			1	1		3	1
⬯	4	4		3	6	6	6				1	2		3
⬯	5	3		5	3	4	6				2	1	2	1
⧖	3	5		6	4	3	3				3	1	1	1
◇	1	1		2	2	1	1		4	2				
⯃	2	2		4	1	4	2		1	3		2		
⯃	2	2		4	6	5	5			2		1	2	1

Fig. 26. Order of difficulty in forming associations between twenty blocks and twenty pictures by a selected group of adults, A, B, D, E, F, and G. The columns on the left half represent the order of difficulty, according to the adult subjects' groupings of the blocks into six groups. The group of easiest associations is designated 1, that next in difficulty, 2, that still more difficult, 3, and so on to 6, the most difficult. The columns on the right half show the frequency of each block in these six groups.

put. It was interesting to note that subjects B, D, E, F, and G placed the blocks in six groupings arranged from easiest to most difficult. Subject A placed them in five groupings. As subject A was the last of the adults to perform the experiment, she was asked, after she had grouped the blocks into five groupings, if it would be possible for her to make one more grouping. She did this so that the

groupings could be compared. Subject C was the first of the adults to perform the experiment and he was not asked to arrange the blocks in order of difficulty. It was a few days after subject C had been given this learning material that the experimenter decided to add the arranging of blocks in order of difficulty to the adult performance of this experiment. This fact explains why in Figure 26, which shows the order of difficulty on the associations with twenty blocks for a selected group of adults, the column for arrangement of blocks by subject C is blank.

A comparison of Figure 26, the order of difficulty in the formation of the associations by adults, with Figure 23, the order of difficulty in the formation of the same associations by preschool children, reveals some interesting facts. It must be kept in mind that Figure 23 represents actual order based upon correct and incorrect responses, and Figure 26 represents only approximate order as arranged by the adult subjects.

Each adult picked out block 1 as the block that was the easiest to associate with its corresponding picture. This agrees perfectly with responses given by the preschool children. Block 18, which is associated with the flower, is placed in the easiest group by four adults and in the next to the easiest group by the two remaining adults. Results show that it was just as easy as block 1 for the junior primary children and held third place in order of difficulty for both preschool and kindergarten children. Block 13, which was second in order for the preschool and kindergarten children and third for the junior primary children, is classed in the easiest group by five adults and in the second group by one adult.

Although there are a number of discrepancies in regard to the difficulty in forming certain of the associations by children and by adults, on the whole there is a high degree of correspondence in order of difficulty in forming the twenty associations involved in this association reaction learning material when adult and preschool subjects are compared. The methods of forming these associations are also similar to a large extent.

CHAPTER VI

SUMMARY, RESULTS, AND CONCLUSIONS

The purpose of this investigation was to study experimentally the psychology of the learning process of young children. The method of approach was through controlled association reaction. Twenty small wooden blocks of geometrical design and twenty simple outline pictures that resemble the blocks in some way furnished the material for this learning experiment. The aim was to use as simple material as possible and to have the response of the child as simple as possible, and at the same time to use material that has an appeal for young children. The learning involved consisted in forming the correct association between each one of the pictures and one of the blocks. The plan of having a certain similarity between block and picture was decided upon in order that the learning would be not too difficult for preschool children. The twenty blocks were devised in such a way that the complete series of blocks may be regarded as consisting of two parallel series arranged in approximate order of complexity, from the simpler to the more complex. Each block of Series II, blocks 11 to 20, is a modification, or variant, of the block that parallels it in Series I, blocks 1 to 10. The material was designed in this way purposely so that it might be presented in several different forms, known as standard and variant forms including the standard form interchanged and the single series form, and learned according to two methods, on successive and on alternate days, in order to investigate some of the important problems involved in the study of the learning process. The criterion of learning in this experiment was three successive perfect trials. Complete learning was checked by reversing the learning situation. If the material had not been learned in twenty trials, or if the child was absent more than three successive days, the experiment was discontinued.

The subjects of the investigation were 203 children from the two groups of Preschool Laboratories of the Iowa Child Welfare Research Station, which are the Preschool Laboratory and the Junior Primary Group of the University Elementary School, and from five kindergartens in a small city in Iowa. The chronological age range

of these children was from two years and two months to six years and five months, and the Stanford-Binet mental age range was from three years and eight months to eight years and eight months. The majority of the children had trials on successive days. Groups of children were paired carefully on the basis of close similarity in Stanford-Binet mental age, height, and weight, and the learning of children in one group to whom the material was presented on successive days was compared with that of another group to whom the material was presented on alternate days. The learning of children in one group who were given only the first half of the material was compared with the learning of those in the other group who were given only the second half of the material. Some of the children who had learned the material according to the standard form of presentation were given it to learn according to one of the variant forms in order to study whether there was transfer or interference in the learning. To a small group of children the material was given for relearning exactly one year after the date of the original learning of the material.

From a quantitative and qualitative analysis of the data from this experiment the following results and conclusions have been obtained:

1. The results of the present investigation show that one perfect performance is inadequate as a criterion of learning, but that when a child has given three successive perfect responses the material may be regarded as having been completely learned.

2. Since the effect of absence on the child's record on learning would be a factor that can not be measured, and since in any learning situation the distribution of work periods and rest periods is of great importance, it was arbitrarily decided before beginning the investigation to discontinue work with any subject who was absent for more than three consecutive days. Among the total number of subjects under discussion there are almost two and a half times as many children who had not a single day's absence as the total number of children who had from one to five days' absence. (One child was absent seven times, which was the maximum.) The influence of absence on progress in learning has, therefore, been reduced to a minimum.

3. Almost every child made some comment upon the similarity of certain of the pictures and their corresponding blocks. The resemblance between pictures and blocks was evident enough for even

the youngest of the children to observe and comment upon. Frequently a child pointed out a resemblance and then added a comment that no doubt helped to fix the association in his mind.

4. The results of this experiment are scored on the basis of the number of trials required for complete learning. When the learning material was presented to the child on successive days the average number of trials for the preschool children was 13.56; for the junior primary children, 7.42; and for the kindergarten children, 7.02. It is interesting to note that the average number of trials required for learning by the preschool children is reduced almost 50 per cent by the junior primary and kindergarten children.

5. For this type of learning, presentation of material on alternate days resulted in greater economy of learning than presentation of material on successive days. The results of the junior primary children who were paired for this part of the experiment show that the group composed of the first child of each pair to whom the learning material was prresented on successive days required an average of 8.73 trials for complete learning, and the group composed of the second child of each pair to whom the material was presented on alternate days required an average of 5.75 trials. The average curve that represents learning on successive days shows more fluctuation than the average curve that represents learning on alternate days.

6. Relearning of the material after an interval of one year was accomplished in fewer trials for all children whose records were used in this part of the investigation than were required by them for the learning.

7. A correlation of $.83 \pm .06$ was found between the number of trials required to learn the material according to the standard form and the number of trials required to learn it immediately after according to the standard form interchanged. This correlation is sufficiently high to be interpreted to mean that the learning of the associations according to the standard form assists in the learning of the interchanged associations rather than interferes with the learning.

8. Results show a marked similarity between the number of trials required by one child of a pair to learn the ten associations of the first half of the complete series, and the number of trials required by the other child of the pair to learn the ten associations of the second half of the complete series. The correlation between the

number of trials required for learning Series I and Series II was .98 ± .05. The average number of trials required for learning Series I was 5.61 and for learning Series II was 5.79. The average number of trials required for learning Series I and Series II was found to be 5.75. It is an interesting point to note that the average number of trials required for learning the complete material according to the standard form of presentation and on alternate days was 5.75, and the average number of trials required for learning only one half of the material on successive days was 5.75. These results seem to have significance from the standpoint of effect of distribution of practice periods upon learning.

9. Three successive perfect scores were followed by a check on learning. For various reasons, some children were not given this check. Of 169 children who had attained three successive perfect scores and were given the check on learning, 164 attained a perfect score on the trial of the check and five children only attained less than a perfect score on the check.

10. Of the 180 children who completed the learning of the material, 111 (61.6 per cent) have no plateaus in their learning curves and sixty-nine have from one to five plateaus. Of the 120 children who learned the material according to the standard form of presentation on successive days, the largest number of children who can be grouped together on the basis of a common factor, seventy-five (62.5 per cent) have no plateaus and forty-five (37.5 per cent) have from one to five plateaus. It is an interesting fact that the percentage of children having no plateaus is almost the same for all forms of presentation considered collectively and for the standard form of presentation, the form by which the largest number of children learned the material. The greatest number of plateaus occurs among the curves of the younger children. From these facts it may be concluded that plateaus are not a necessity in the association reaction type of learning and that whether or not they occur seems to be a matter of individual differences and maturity. The majority of the plateaus may be regarded, therefore, as epiphenomena, that is chance fluctuations without statistical significance.

11. The difference in response on the first trial between children accustomed to psychological tests and those unaccustomed to them is well demonstrated in the results obtained from the children in the Junior Primary Group and in the kindergartens, in which the children are comparable in age and school status. The children from

the Preschool Laboratories of the Iowa Child Welfare Research Station are thoroughly accustomed to psychological test conditions. The kindergarten children are totally unfamiliar with psychological tests. The kindergarten children unaccustomed to test conditions began with lower scores, but completed the learning in the same number of trials as children of the same mental age who are habituated to the taking of psychological tests.

12. An analysis was made of the correct and incorrect responses given during the experiment as a means of studying the order of difficulty in forming the required associations. There is a very close similarity between the order of difficulty for the children in the three groups. As would be supposed, the order of difficulty is more alike between the junior primary and the kindergarten children than between the preschool and the junior primary children or between the preschool and the kindergarten children. Correlations for each combination of two of the groups of children based on the similarity in order of difficulty in forming the required associations were (1) preschool and junior primary .84 ± .04; (2) preschool and kindergarten .86 ± .04; and (3) junior primary and kindergarten .95 ± .17.

13. The reliabililty of the experiment was found by correlating the scores on one half of the material (Series I) with the scores on the other half of the material (Series II); it was found to be .83 ± .01 for the children in the Preschool Laboratories and the kindergarten children. When the reliability coefficient of the experiment was found by correlating the scores on odd and even items of the material it was found to be .87 ± .01 for the children in the Preschool Laboratories and .85 ± .01 for the kindergarten children. When the Spearman-Brown prophecy formula was applied for the two halves of the material, the result was .91 for both groups. When the Spearman-Brown prophecy formula was applied for the odd and even items of the material, the result was .93 for all the children in the Preschool Laboratories and .92 for the kindergarten children. The correlation of Series I and Series II was based upon the records of the children who learned all of the material of both series together as one series. A correlation of the scores on Series I and Series II of paired kindergarten children, one of each pair having learned Series I only and the other of the pair having learned Series II only, gives a reliability coefficient of .98 ± .05.

14. The correlations between the number of trials necessary for

complete learning of the material and the Stanford-Binet mental age were —.40 ± .08, —.47 ± .07, —.48 ± .10, —.52 ± .06, —.58 ± .07, for the various groups. The negative correlations must be interpreted as follows: on the Stanford-Binet, the higher the mental age is in relation to the chronological age, the better is the child's performance, whereas, for the learning material, the fewer the number of trials required for complete learning, the better is the child's performance. Thus, instead of having an increase in score to denote superior performance on the learning material, as is the usual method of scoring psychological tests, a superior performance on the learning material is denoted by a decrease in number of trials required for complete learning as compared with the number of trials required for complete learning when the performance is either average or below average. The correlations are sufficiently high to be interpreted that the higher the mental age, the fewer the number of trials required for complete learning of the association reaction learning material. The number of trials necessary for complete learning correlates better with mental age than with chronological age.

15. The correlation between the number of trials required for complete learning of the association reaction material and the scores on the Detroit kindergarten test was —.33 ± .08 for the kindergarten children, indicating that those children who are above average in mental age require fewer than average number of trials for completing the learning. On a small group of the children from the Preschool Laboratories, about one third as many as were included in the kindergarten group, the correlation between the number of trials and the score on the Detroit kindergarten test was found to be —.26 ± .13, and therefore not significant.

16. The correlations between the number of trials required for complete learning of the association reaction material and the scores on the Goddard-Seguin form board test, manikin test, and Montessori cylinders test were computed, but in no case found to be significant.

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There has been so little investigation of the problem of learning in young children that the literature contains few references that have a specific relation to the present experiment. The references have therefore been grouped under general references and according to the subjects used in experiments in learning, animals, adults, school children, and preschool children.

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